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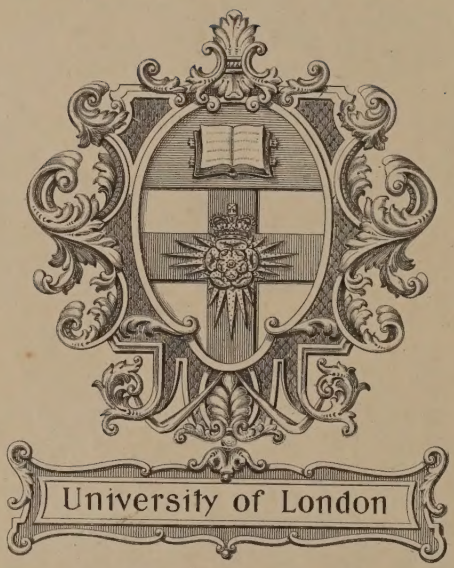

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REPORTS

FROM

COMMITTEES:

SEVEN VOLUMES.

—*(6.)*—

ORDNANCE.

Session

5 February —— *28 July* 1863.

VOL. XI.

1863.

REPORTS FROM COMMITTEES:

1863.

SEVEN VOLUMES:—CONTENTS OF THE

SIXTH VOLUME.

N.B.—*THE* Figures *at the* beginning of the line, *correspond with the* N° *at the foot of each* Report; *and the* Figures *at the* end of the line, *refer to the* MS. Paging *of the Volumes arranged for The House of Commons.*

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REPORT

FROM THE

SELECT COMMITTEE

ON

ORDNANCE;

TOGETHER WITH THE

PROCEEDINGS OF THE COMMITTEE,

MINUTES OF EVIDENCE,

APPENDIX, AND INDEX.

Ordered, by The House of Commons, *to be Printed,*
23 *July* 1863.

Veneris, 20° *die Februarii*, 1863.

Ordered, That a Select Committee be appointed to inquire into the Expenditure incurred since the beginning of 1858 on various natures of improved Ordnance, whether obtained by Contract, or manufactured in the Public Departments, and into the Results obtained by such Expenditure.

Jovis, 26° *die Februarii*, 1863.

Committee nominated of—

Mr. Monsell.	Sir John Hay.
Sir George Lewis.	Lord Robert Cecil.
General Peel.	Mr. Laird.
Captain Jervis.	Major O'Reilly.
Mr. T. G. Baring.	Mr. Beecroft.
Sir Frederic Smith.	Sir Morton Peto.
Mr. Dodson.	Mr. Vivian.

Ordered, That the Committee have power to send for Persons, Papers, and Records.

Ordered, That Five be the Quorum of the Committee.

Veneris, 27° *die Februarii*, 1863.

Ordered, That Colonel Dunne be added to the Committee.

Ordered, That the Report of the Select Committee of Session 1862, on Ordnance, be referred to the Committee.

Mercurii, 22° *die Aprilis*, 1863.

Ordered, That the Marquis of Hartington be added to the Committee.

Martis, 30° *die Junii*, 1863.

Ordered, That the Copy of the Report of the Ordnance Committee on the merits of the several plans for rifling the existing Cast-iron Service Guns (presented 5th May), be referred to the Committee.

Jovis, 23° *die Julii*, 1863.

Ordered, That the Committee have power to report their Observations, together with the Minutes of Evidence taken before them, to The House.

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REPORT.

THE SELECT COMMITTEE appointed to Inquire into the EXPENDITURE Incurred since the beginning of 1858 on Various Natures of IMPROVED ORDNANCE, whether obtained by Contract, or Manufactured in the Public Departments, and into the Results obtained by such Expenditure;—— HAVE considered the Matters to them Referred, and have Agreed to the following REPORT:

YOUR Committee have taken into consideration the evidence given before the Ordnance Committee of last Session, and have themselves examined witnesses.

As almost the whole of the expenditure they have inquired into has been incurred upon Armstrong guns and ammunition, it is necessary to commence with a short history of the introduction of that system of ordnance into Her Majesty's service.

It appears that the Armstrong gun was first brought to the notice of the Government in December 1854, when the Duke of Newcastle (then Secretary of State for War) gave Sir W. Armstrong (then Mr. Armstrong) an order for a number of his guns, not exceeding six, for trial. App., 1862. p. 156.

The first of these guns, a three-pounder, was delivered in July 1855, when Mr. Armstrong forwarded a detailed report of the experiments he had made, and of the principle of the construction of his gun and projectiles. The whole subject was referred to the Ordnance Select Committee, whose report, though qualified, was, in the main, favourable to the gun, and who desired to make further experiments. p. 158. p. 163.

The gun was re-bored up to a 5-pounder, and, in December 1856, was tried in the presence of Colonel Eardley Wilmot (Superintendent, Royal Gun Factory), near Newcastle, who reported, 30th December 1856, that at 1,500 and 2,000 yards, the gun had made remarkably good practice.

In January 1857, a second gun was ordered to correspond as nearly as possible with the service 9-pounder field gun. This gun, an 18-pounder, was reported ready on 1st July 1857, and the programme of the trial arranged 14th October; but the trial was delayed, owing to Mr. Armstrong's absence on the continent, until 26 January 1858, when experiments were made with it in competition with a service 32-pounder gun, which were reported by the Ordnance Select Committee, 5th February 1858. p. 164.

The result was so satisfactory that Lord Panmure expressed himself thus:— "I am clearly of opinion that this is a most valuable contribution to our army. For all purposes of projection and accuracy of flight of the projectiles, the experiments are conclusive; and we should have two more guns made of the same size as that which has been tried at Shoeburyness, one of which may be without the recoil slide, and they should be handed over to the artillery to knock about, and be reported upon as to their endurance of work in comparison with our service guns."

Colonel Mitchell made a further report on this trial, detailing further experiments which he desired might be made. p. 165.

App., 1862. On 25th February two 18-pounder guns were ordered, and on 13th of April one 12-pounder, and 400 projectiles for the 18-pounders were ordered for further experiments.

p. 158. A full description of the first gun supplied by Sir William Armstrong to the Government will be found in his Report, dated the 14th of July 1855.

Evidence, 1862. 2308. In 1858 the attention of General Peel, who had just accepted the office of Secretary of State for War, was directed to the circumstance that we were behind other countries in not having any rifled ordnance for field service. He accordingly called upon Colonel Lefroy, his scientific adviser, for a report on all the experiments that had been tried on rifled ordnance; and in accordance with the recommendation of that report, appointed a special Committee to advise him as to what was the best rifled gun for field service. This special Committee, after analysing the reports in the possession of the War Department on the various rifled guns which had been submitted to the Select Committee, came to the conclusion that it was not expedient to incur the expense of trying further experiments with any except those of Messrs. Whitworth and Armstrong. They proceeded, therefore, to try the Whitworth and Armstrong guns.

App., 1862. p. 166.

Evidence, 1863. 3105. It appears that the experiments with the Whitworth gun were not of as extended a character as those with the Armstrong gun. At that time Mr. Whitworth had not any gun of his own construction, nor did he propose any system of constructing guns. He had only rifled Government blocks of brass and cast-iron. The system proposed by Mr. Armstrong was therefore the only complete one before the Committee.

On the other hand, Mr. Armstrong proposed a method of constructing a gun which rendered it capable of enduring the strain to which rifled ordnance is submitted. This method was certainly at that time the only one capable of fulfilling that condition, and your Committee have had no practical evidence before them that, even at this moment, any other method of constructing rifled ordnance exists which can be compared to that of Mr. Armstrong. In combination with his system of constructing or manufacturing a gun, Mr. Armstrong had introduced to the notice of the Government a plan of breech-loading, the gun being rifled on the old polygroove system, which involved the coating of the projectile with soft metal. This combination of construction, breech-loading, rifling, and coating the projectiles with soft metal, came to be viewed as the Armstrong system. The range and precision of the gun were so vastly superior to all field ordnance known at that time, that after careful and repeated trials, the Committee appointed to investigate the question recommended its adoption as the field gun of the service. Your Committee are of opinion that the adoption of the Armstrong gun by the Secretary of State for War for special service in the field was fully justified.

A guarantee was given to Sir W. Armstrong that he should not be a loser by the expenditure of 12,000 *l.* on a plant, sufficient to enable him to turn out 100 guns a year. This guarantee was afterwards increased; but Lord Derby, in a letter addressed to General Peel on the 18th of December 1858, said that he should rather doubt the expediency in the present infancy of the invention, and when doubtless time and experience will both suggest improvements and produce economy in manufacture, of pressing for the immediate supply of a large number of guns, of the first type and at the highest rate. He also suggested that the first orders should be confined chiefly, if not exclusively, to that class of guns, say 32-pounders, of which we have had sufficient proof, and that we should defer any order for heavier guns till they had been rather more tested.

On the 15th of January 1859, Sir W. Armstrong assigned his interest in all patents for and improvements in the manufacture of ordnance to the Government.

5078. The Secretary of State for War has declined to submit these patents to your Committee, on the ground that he is disposed to think that it would be contrary to public policy to produce patents of this description.

In order to obtain as soon as possible a supply of Armstrong guns, it was decided to enter into arrangements with a company set up at Elswick for the manufacture of Armstrong guns and projectiles; a guarantee was given to this company, on the 16th January 1859, to secure them against loss by the

the erection of buildings and machinery. The Government undertook to keep them in full work, but kept in its own hands the power of terminating the engagement on the payment of compensation. The necessities of the Service requiring a larger number of Armstrong guns to be provided than were at first anticipated, the guarantee given by Lord Derby's Government was increased, first to 50,000 *l.*, and then to 60,000 *l.* After General Peel left office, Lord Herbert, in October 1859, owing to the increased pressure for guns, raised the guarantee to its final amount of 85,000 *l.* Evidence, 1863.

This agreement was terminated in April of this year, and 85,000 *l.* has been paid to the Company. Lord De Grey states that value of over 19,000 *l.* in plant and stores, has been received. This would make the amount paid as compensation about 65,000 *l.* 5031. App., 1863, No. 48.

Sir W. Armstrong was, on the 22d of February 1859, appointed Engineer of Rifled Ordnance. The definitions of his duties and terms of his appointment will be found in page 177 of the Appendix of the Report of the Select Committee of last Session. On the 4th November 1859 he became, also, Superintendent of the Royal Gun Factory for Rifled Ordnance. Sir William Armstrong resigned these offices on the 5th of February last, and has ceased to be an officer of the Government. Parliamentary Paper 127, 1863.

It appears from the correspondence produced to your Committee, that in the winter of 1858–9, the Board of Admiralty, acting upon the advice of Captain Hewlett, R.N., of Her Majesty's Ship "Excellent," gunnery ship at Portsmouth, decided upon the introduction of the Armstrong guns into the Navy for boat service; and in the summer of 1859, the same officer having urged the importance of introducing into the Navy larger calibres of Armstrong guns, the Board of Admiralty requested the Secretary of State for War, in the strongest manner, to supply them with as little delay as possible with a large number of 40-pounder and 70-pounder Armstrong guns. App., 1862. p. 246. p. 247.

At the same time, careful and extensive experiments were carried on, to test whether any safe system of strengthening cast-iron guns could be found, or whether any better, speedier, or cheaper system of constructing rifled guns existed than that proposed by Sir W. Armstrong. None such having been found within the period for inquiry, the Armstrong system was completely adopted by the Government. Evidence, 1863. 5230, 5233–34. Evidence (1862), 177 *et seq.* 2763, 2765. Ordnance Report App. (1862), p. 207. Report of Ordnance Select Committee on Cast Iron Ordnance, Parliamentary Paper, 1863.

On the 24th of September 1859, a Committee, of which Sir William Armstrong was a member, approved of the pattern of the Armstrong 40-pounder for naval service. The Armstrong system was first extended to the 110 calibre on the 14th October 1859. The political necessities of the day appear to have been so urgent as not to allow time for maturing the design previous to its manufacture. In consequence of the excessive pressure which existed at that time for the supply of guns of that calibre, the first 100 of these were constructed before any experiments upon them had been concluded.

The whole supply of Armstrong guns and projectiles has been obtained from the Royal Arsenal at Woolwich and the Elswick Ordnance Factory.

1st. The sum of 965,117 *l.* 9 *s.* 7 *d.* has been paid to the Elswick Ordnance Company for articles supplied. App., 1863, No. 44.

2d. After giving credit for the value of plant and stores received from the Company, a sum of 65,534 *l.* 4 *s.* has been paid to the Elswick Ordnance Company as compensation for terminating the contract.

3d. The outstanding liabilities of the War Office to the Elswick Ordnance Company, for articles ordered, amounted on the 7th May last to the sum of 37,143 *l.* 2 *s.* 10 *d.*

The whole of these payments and liabilities amounts to the sum of 1,067,794 *l.* 16 *s.* 5 *d.*

4th. The sum of 1,471,753 *l.* 1 *s.* 3 *d.* has been expended in the three manufacturing departments at Woolwich on the Armstrong guns, ammunition, and carriages, making altogether a grand total of 2,539,547 *l.* 17 *s.* 8 *d.*

App., 1863, No 44. A statement has been prepared by Mr. Whiffin, one of the Assistant Accountants General of the War Office, at the request of your Committee, showing the cost of certain guns and projectiles obtained from the Elswick Ordnance Company, compared with the rates of those produced at the Royal Arsenal, Woolwich. According to this statement, taking the class of stores which have been supplied from Elswick and from Woolwich, and which therefore admit of a direct comparison, the sum of 242,173*l.* 10*s.* 6*d.* on an expenditure of 593,275*l.* 10*s.* 11*d.* would have been saved to the public had these guns, projectiles, and fuzes, supplied by the Elswick Ordnance Company, been manufactured in the Royal Arsenal. It is obvious that the value of this comparison rests entirely upon the accuracy of the principle upon which the cost of the articles produced at Woolwich has been arrived at.

The evidence on this subject is conflicting.

5575-6, 7. 5706. 5716. On the one hand, Colonel Boxer, Superintendent of the Royal Laboratory, and Mr. Whiffin, state their belief that their comparison of the prices at Elswick and Woolwich is substantially correct. Mr. Rendel and Captain Noble, R.A., partners in the Elswick Company, object to any such comparison until the Royal Arsenal prices are ascertained on what they consider an accurate basis. Mr. Anderson, Assistant Superintendent of the Royal Gun Factory, who alone was responsible for the accounts, is of opinion that some saving would have been effected if all the guns had been manufactured at the Royal Arsenal, but he is unable to say exactly what is the whole cost of the Royal Gun Factory guns; and Mr. Baring, a Member of your Committee, and some time Under Secretary of State for War, is of opinion that the comparison between the Elswick prices and the Woolwich rates is of no value for practical purposes.

Evidence, 1862. 1334. 1362. Evidence, 1863. 5484. 5478-89. 5266.

5502. 5088-89. 5043. 5086. Looking to the necessity for the application to the Elswick Company in the first instance, and to the fact that for two subsequent years both the Royal Gun Factory and the Elswick Works were employed to extremity, your Committee find themselves unprepared to impugn the wisdom of the course adopted by General Peel, and followed, by succeeding Administrations, with respect to the Elswick Company.

Your Committee have received various and most conflicting evidence with regard to the results of this large expenditure.

The 12-pounders, although stated by some of the witnesses to be too complicated a weapon for service, are generally approved of.

Evidence, 1863. 1250, 1251. 374, 375. 524. 534. It appears to your Committee that the Armstrong field-gun is the best known for field purposes. His Royal Highness the Field Marshal Commanding in Chief states that, in his opinion, Sir W. Armstrong's system surpasses in completeness any other, and his conviction is that England in this respect is ahead of any other country. Colonel Bingham, Adjutant General of Artillery, states that he is perfectly satisfied with the Armstrong field-gun; that it is the best gun known, and that this is the general opinion of officers of Artillery of all classes. At the same time, some of the military officers examined state that, in their opinion, we ought not entirely to rely (for field artillery) on breech-loading guns, as being complicated and liable to injuries from rough handling and various accidents, and are inclined to retain a proportion of muzzle-loading guns for horse artillery.

368. The attention of your Committee was drawn to the failure of some of these field-guns; this appears to have arisen from faulty manufacture. The chief defect complained of was that certain guns were patched up, but it appears 384. that the sealed pattern given at Woolwich was a lined gun. This gun was 550. sealed upon the recommendation of the Select Committee. Mr. Anderson, in reference to Colonel Bingham's statement, that half the field-guns in the Service are patched up, says: "To bring our 1863 knowledge and experience and 567. standard to test the guns of 1859 would, I think, not be fair. We do not think very much of those guns now; the guns of 1861 were very much better than the guns of 1859; the gun of 1862 is better than the gun of 1861. And with my present knowledge, I think the guns of last year are very bad in many particulars; but even taking the first gun, with its many defects (and I speak deliberately), I do not know of any breech-loading gun outside the War Department

Department that is yet equal to it. Although it is the worst of all, still it is a very good gun. If I had known that those linings would have been spoken of, or if Sir William Armstrong had known it, we should not have lined them; we would have bored them out. They were to be made for 200 *l.* a piece, and they have been made at 87 *l.*; and now, working that price up to 100 *l.*, I have made them as good as any guns that were ever made." He positively denies that the lining complained of by Colonel Bingham was the cause of the failure of the guns. On careful investigation your Committee find that out of 570 12-pounders issued and in use, 13 only have been returned to the Royal gun factories for repair, three of which have proved unserviceable, and the remainder repairable at an inconsiderable expense. 548. 568.

As to the 40-pounders, the accounts of various experiments with these guns will be found in the reports from Her Majesty's ships "Excellent," "Cambridge," and "Emerald," contained in the Appendix.

As to the 110-pounders, it is on all hands admitted that although useful as chase guns, they ought not to be introduced into the naval service as broadside Guns. They were originally required for use against wooden ships, and, whilst not sufficiently powerful for penetrating iron-plated ships, are as yet imperfect for general naval service, owing to the difficulty of managing and manufacturing the vent-piece. Nevertheless, the 110-pounder is considered by naval men of eminence in their profession as a most valuable weapon in its present proportion to the armament of a ship, and the Duke of Somerset is of opinion that the Navy has not got too many of them. Evidence 1863. 5156. 2159. 3188. 2268. 5136. 3174. 3274. 2233. 4554. 5157, 5183.

The Duke of Somerset states that "We have nothing better now for close "quarters than the 68-pounder," and concurs with all the naval witnesses in considering that in the armament of Her Majesty's ships only a small proportion of 100 pounders should be included. His Grace further adds "that it was not "till we tried a 100-pounder and a 68-pounder against Captain Coles' cupola, "that he became aware that the 68-pounder struck a harder blow than the "100-pounder at short range." It should be observed that this comparison was made when the charge of the 100-pounder was 14 lbs.; it has now been reduced to 12 lbs. The Duke of Somerset, however, further stated that many experiments had recently been made with shot weighing about 69 lbs. fired from the 110-pounder Armstrong gun, with the old 68-pounder charge of powder;—that this had helped to correct an error. "It was imagined that a "smooth-bore gun must have greater velocity than a rifled gun." "That was "an error which we have corrected gradually with increased experience. Those "experiments have tended to put us right on those points." 5109. 5102. 5108. 5133–4.

The Duke of Somerset also further informed your Committee that the Admiralty "had a report that the Armstrong gun had the greatest range and the "greatest power of penetration of any gun tried; when they came to try it "themselves, that was not confirmed by the facts; the Armstrong gun at a "great distance may have had greater power of penetration, but for naval pur-"poses at 200 yards, it certainly had not the greatest power; our old 68-pounder "is a more powerful gun than the 100-pounder Armstrong gun." 5102.

The old 68-pounder is therefore the most effective gun in the service against iron plates.

As to the principle of constructing his guns of coiled iron tubes, Sir W. Armstrong states that he began with 3-pounders of 5 cwt., and has ascended step by step to 600-pounders of 22 tons, and that the safety of this principle has, he considers, been established by the fact that out of nearly 3,000 guns, no one gun has burst explosively; and, in fact, no one gun has failed under the most trying tests, excepting by a gradual process. 3163.

While almost every witness has borne testimony to the superior accuracy and range of the Armstrong guns great doubts have been expressed as to whether they are not too delicate a weapon and too liable to get out of order to be entirely relied upon in actual warfare. It must be remarked, however, that the officers who commanded Armstrong batteries in the late operations in China found no difficulty in keeping them in order in all weathers and under all circumstances. 8. 131. 175, 327. 1232. 1568. 2166. 2184. 8. 3209, 2184, 3802. 2299. App. 1863. No. 46.

The testimony as to the Armstrong shell has been universally favourable; it is described as the most destructive weapon ever used against wooden ships, and most formidable in its effects and range.

The time-fuzes have been uncertain, and have been condemned.

Evidence, 1863. 3438. Sir William Armstrong, however, states that the concussion and time fuzes for land service are now perfectly satisfactory; and that with respect to the sea-service fuzes, the pillar fuze is the only one which is matured; the time fuze now used being merely a temporary expedient until a more perfect fuze can be produced.

As to the various details involved in the Armstrong system, your Committee can only refer to the scientific evidence given before them. The preponderance of opinion seems to be against any breech-loading system for larger guns.

No sufficient experiments have been tried to show whether mechanical fitting projectiles are liable to the objections made against them, that they must tend to destroy the gun from which they are fired.

The shunt system by which it is attempted to have muzzle-loading guns rifled without mechanical fitting projectiles is still an experiment.

Without expressing any opinion on these controverted questions, your Committee venture to express a hope that the different systems, not of Sir W. Armstrong and Mr. Whitworth only, but of the other able men whose minds are now engaged on ordnance questions, may be fairly experimented upon.

No trials can be altogether satisfactory to which, under proper restrictions, scientific men are not admitted. Neither can systems of rifling fairly compete with one another unless the guns in which they are tried are made with equal skill, and with, in every case, the best available materials.

It appears to your Committee that a uniform system of accounts should be adopted for the manufacturing departments at Woolwich, by which the cost of guns and other produce may be clearly ascertained. The absence of such a system has much embarrassed your Committee in comparing the cost of guns made in the Royal Gun Factories, and the price charged by the Elswick Ordnance Company.

23 *July* 1863.

PROCEEDINGS OF THE COMMITTEE.

Veneris, 27° *die Februarii*, 1863.

MEMBERS PRESENT:

Mr. Monsell.	Sir George Lewis.
Sir John Hay.	Sir Frederic Smith.
Captain Jervis.	Lord Robert Cecil.
Mr. Beecroft.	Mr. Laird.
Major O'Reilly.	

Mr. *Monsell* called to the Chair.

The Committee deliberated.

[Adjourned to Thursday, 12th March, at One o'clock.

Jovis, 12° *die Martii*, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Mr. Beecroft.	Mr. Laird.
Sir John Hay.	Sir George Lewis.
Major O'Reilly.	Sir M. Peto.
Captain Jervis.	General Peel.
Mr. Dodson.	

Colonel *W. B. Gardiner*, R.A., examined.

[Adjourned to Thursday next, at One o'clock.

Jovis, 19° *die Martii*, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Mr. Beecroft.	Mr. Dodson.
Sir John Hay.	Mr. Laird.
Major O'Reilly.	Sir George Lewis.
General Peel.	Mr. T. G. Baring.
Colonel Dunne.	Captain Jervis.

Captain Sir *William Wiseman*, and Colonel *Charles Bingham*, severally examined.

[Adjourned to Monday next, at One o'clock.

Lunæ, 23° *die Martii*, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Mr. Beecroft.	Sir F. Smith.
Sir John Hay.	Mr. T. G. Baring.
Major O'Reilly.	Sir M. Peto.
General Peel.	Sir George Lewis.
Colonel Dunne.	Lord Robert Cecil.
Mr. Dodson.	Captain Jervis.
Mr. Laird.	

Mr. *John Anderson*, Lieutenant Colonel *Edward M. Boxer*, and Colonel *Henry Clark*, severally examined.

[Adjourned to Monday, 20 April, at One o'clock.

Lunæ, 20° *die Aprilis*, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Mr. T. G. Baring.	Major O'Reilly.
Sir Frederic Smith.	Colonel Dunne.
Mr. Dodson.	Mr. Beecroft.
Sir John Hay.	Captain Jervis.
Lord Robert Cecil.	Mr. Vivian.
Mr. Laird.	

Colonel *W. H. Gordon*, and Mr. *Joseph Whitworth*, severally examined.

[Adjourned to Thursday next, at One o'clock.

Jovis, 23 *die Aprilis*, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Sir John Hay.	Mr. Beecroft.
Major O'Reilly.	Mr. T. G. Baring.
Colonel Dunne.	Mr. Laird.
Sir Frederic Smith.	Sir Morton Peto.
Captain Jervis.	Lord Robert Cecil.
Mr. Dodson.	Mr. Vivian.

His Royal Highness the Duke of *Cambridge* (attending by permission of the House of Lords), examined.

Mr. *John Anderson*, and Mr. *Joseph Whitworth*, severally further examined.

Mr. *William Wilson Hulse* examined.

[Adjourned to Monday next, at One o'clock.

Lunæ, 27° *die Aprilis*, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Lord Robert Cecil.	Sir Frederic Smith.
Colonel Dunne.	Mr. Beecroft.
Mr. Laird.	Sir Morton Peto.
Mr. Vivian.	Mr. Dodson.
Mr. T. G. Baring.	Marquis of Hartington.
Captain Jervis.	

Captain *C. Coles*, Mr. *Isambard Brunel* and Mr. *John Anderson* examined.

[Adjourned to Thursday next, at One o'clock.

Jovis, 30° *die Aprilis*, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Major O'Reilly.	Mr. Beecroft.
Colonel Dunne.	Mr. T. G. Baring.
Captain Jervis.	Sir John Hay.
Mr. Laird.	Marquis of Hartington.
Mr. Vivian.	

Mr. *John Anderson*, and Mr. *Joseph Whitworth*, severally further examined.

The Committee deliberated.

Motion made, and Question, "That the Chairman be instructed to inform Mr. Whitworth, that, having placed his reply to the Report of the Select Committee in the Minutes of their Evidence, they do not think it within the Order of Reference to decide between him and the Ordnance Select Committee; the question at issue being a matter of opinion, the Committee do not see any reason to question the veracity of Mr. Whitworth's evidence given before them"—(Colonel *Dunne*)—put, and agreed to.

Mr. *Whitworth*, and Mr. *William Hulse*, severally further examined.

Adjourned to Monday next, at One o'clock.

Lunæ, 4° *die Maii*, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Major O'Reilly.	Mr. Beecroft.
Lord Robert Cecil.	Sir Frederic Smith.
Colonel Dunne.	Marquis of Hartington.
Captain Jervis.	Mr. T. G. Baring.
General Peel.	Sir M. Peto.
Mr. Dodson.	

Captain *H. W. Gordon* further examined.

The Earl of *Lauderdale*, the Marquis of *Hartington* (a Member of the Committee), Captain *H. J. W. Jervis* (a Member of the Committee), Major General Sir *Richard J. Dacres*, Captain *Arthur Cochrane*, R.N., and Captain *F. B. Seymour*, R.N., severally examined.

[Adjourned to Thursday next, at One o'clock.

Jovis, 7° die Maii, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Major O'Reilly.	Mr. T. G. Baring.
Colonel Dunne.	General Peel.
Captain Jervis.	Sir F. Smith.
Sir John Hay.	Marquis of Hartington.
Mr. Vivian.	Sir Morton Peto.
Mr. Beecroft.	Mr. Dodson.

Mr. *Joseph Whitworth* further examined.

The Committee deliberated.

Motion made, and Question, "That so much of the answer of the witness as follows the words 'I do not pretend to have any opinion; it is a question for an artillery officer,' be read"—(Major *O'Reilly*)—put, and agreed to.

The same was read accordingly.

Motion made, and Question put, "That those words be expunged"—(Major *O'Reilly*):—The Committee divided.

Ayes, 7.	Noes, 4.
Major O'Reilly.	Colonel Dunne.
Mr. Vivian.	Captain Jervis.
Mr. F. Smith.	Sir J. Hay.
Mr. Beecroft.	General Peel.
Sir Morton Peto.	
Mr. Dodson.	
Marquis of Hartington.	

Motion made, and Question, "That the evidence given (on the 4th instant) by the Marquis of Hartington and by Captain Jervis respectively, be now read"—(Captain *Jervis*),—put, and agreed to.

The same was read accordingly.

Motion made, and Question, "That the said evidence be expunged"—(Captain *Jervis*)—put, and agreed to.

Mr. *Whitworth* further examined.

[Adjourned to Monday next, at One o'clock.

Lunæ, 11° *die Maii,* 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Major O'Reilly.	Mr. Vivian.
Colonel Dunne.	Mr. T. G. Baring.
Captain Jervis.	Mr. Dodson.
Sir John Hay.	General Peel.
Mr. Laird.	Marquis of Hartington.
Mr. Beecroft.	

Major General *Alexander Thomas Tulloh* examined.

Mr. *Whitworth* further examined.

The Committee deliberated.

Minute of the Proceedings of the Committee of the 7th instant, read.

Resolved, That the two Questions and Answers following Mr. Whitworth's answer already expunged, be read.

The same were read accordingly.

Resolved, That the said evidence be expunged.

[Adjourned to Thursday next, at Two o'clock.

Jovis, 14° *die Maii*, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Colonel Dunne.	Mr. T. G. Baring.
Mr. Laird.	Sir John Hay.
Mr. Vivian.	Sir F. Smith.
Mr. Dodson.	Captain Jervis.
Mr. Beecroft.	

Mr. *H. W. S. Whiffen*, Captain *Andrew Noble*, and Sir *William G. Armstrong*, severally examined.

[Adjourned to Monday next, at One o'clock.

Lunæ, 18° *die Maii*, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Sir John Hay.	Mr. Laird.
Mr. T. G. Baring.	Sir Morton Peto.
Mr. Beecroft.	Lord Robert Cecil.
Captain Jervis.	Major O'Reilly.
Mr. Vivian.	Sir Frederic Smith.
Marquis of Hartington.	

Rear Admiral *Sydney Dacres* examined.

Sir *William Armstrong* further examined.

[Adjourned to Monday, 1st June, at One o'clock.

Lunæ, 1° *die Junii*, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Sir John Hay.	Mr. Laird.
Mr. Beecroft.	Major O'Reilly.
Captain Jervis.	Mr. T. G. Baring.
General Peel.	Lord Robert Cecil.
Mr. Vivian.	Marquis of Hartington.

Captain *R. S. Hewlett*, R. N., examined.

Sir *William Armstrong* further examined.

[Adjourned to Thursday next, at Ten o'clock.

Jovis, 4° *die Junii*, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Sir John Hay.	Sir M. Peto.
Mr. Beecroft.	Mr. Dodson.
Major O'Reilly.	Mr. Laird.
Captain Jervis.	

Captain *A. W. Jerningham*, R. N., and Captain *James F. B. Wainwright*, R. N., severally examined.

[Adjourned to Monday next, at One o'clock.

Lunæ, 8° *die Junii*, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

General Peel.	Marquis of Hartington.
Mr. Vivian.	Mr. T. G. Baring.
Sir John Hay.	Mr. Dodson.
Captain Jervis.	Major O'Reilly.
Colonel Dunne.	Mr. Laird.

Sir *William Armstrong* further examined.

The Committee deliberated.

Sir *William Armstrong* further examined.

[Adjourned till Thursday next, at One o'clock

Jovis, 11° *die Junii*, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Mr. Beecroft.	Mr. Laird.
Colonel Dunne.	Mr. Dodson.
Sir John Hay.	General Peel.
Major O'Reilly.	Mr. T. G. Baring.
Captain Jervis.	Sir Morton Peto.
Mr. Vivian.	Marquis of Hartington.

Mr. *Westley Richards* examined.

The Committee deliberated.

Motion made, and Question put, "That Captain A. T. Blakeley be now examined,"—(Mr. *Vivian*).—The Committee divided:

Ayes, 8.	Noes, 3.
Mr. Baring.	Colonel Dunne.
Mr. Beecroft.	Sir John Hay.
Mr. Dodson.	Captain Jervis.
Mr. Laird.	
Major O'Reilly.	
General Peel.	
Sir M. Peto.	
Mr. Vivian.	

Motion made, and Question, "That the Chairman do move the House, That the Report "of the Ordnance Committee on the merits of the several plans proposed for rifling the "existing cast-iron service guns, be referred to this Committee"—(Colonel *Dunne*)—put, and agreed to.

Captain *Robert A. E. Scott*, R.N., examined.

[Adjourned to Monday next, at One o'clock.

Lunæ, 15° *die Junii*, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Mr. Beecroft.	Sir Frederic Smith.
Captain Jervis.	Sir Morton Peto.
Major O'Reilly.	Mr. Laird.
Colonel Dunne.	Marquis of Hartington.
General Peel.	Mr. Dodson.
Mr. T. G. Baring.	

Captain *Robert Scott* further examined.

Captain *Charles Ewart*, R.N., examined.

[Adjourned to Thursday next, at One o'clock.

Jovis, 18° *die Junii*, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Mr. Beecroft.	Mr. Laird.
Colonel Dunne.	Sir Frederic Smith.
General Peel.	Mr. T. G. Baring.
Captain Jervis.	

Captain *A. T. Blakeley* examined.

[Adjourned to Monday next, at One o'clock.

Lunæ, 22° *die Junii*, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Captain Jervis.	Mr. Dodson.
Sir John Hay.	Mr. T. G. Baring.
General Peel.	Mr. Beecroft.
Colonel Dunne.	Marquis of Hartington.
Major O'Reilly.	Sir F. Smith.
Mr. Laird.	

Motion made, and Question proposed, "That the Chairman be instructed to move an Address to the Crown, praying that a copy of the various patents and specifications for the Armstrong gun be laid before the Committee,"—(Mr. *Laird*).—The Committee deliberated.

[Adjourned to Monday next, at One o'clock.

Lunæ, 29° *die Junii*, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Major O'Reilly.	Sir Morton Peto.
General Peel.	Mr. Beecroft.
Mr. Laird.	Sir John Hay.
Mr. T. G. Baring.	Marquis of Hartington.
Colonel Dunne.	

Sir *William Armstrong* further examined.

The Committee deliberated.

Question again proposed, "That the Chairman be instructed to move an Address to the Crown, praying that a copy of the patent and specification for the Armstrong gun be laid before the House"—(Mr. *Laird*).—Motion, by leave, withdrawn.

[Adjourned to Thursday next, at One o'clock.

Jovis, 2° die Julii, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Captain Jervis.	Marquis of Hartington.
Mr. Laird.	General Peel.
Sir John Hay.	Colonel Dunne.
Mr. T. G. Baring.	Mr. Vivian.
Mr. Beecroft.	Sir Frederic Smith.
Mr. Dodson.	Sir Morton Peto.

The Earl *de Grey and Ripon*, and the Duke of *Somerset* (attending by permission of the House of Lords), severally examined.

[Adjourned to Monday next, at One o'clock.

Lunæ, 6° die Julii, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Mr. T. G. Baring.	General Peel.
Mr. Beecroft.	Colonel Dunne.
Mr. Laird.	Sir Frederic Smith.
Mr. Vivian.	Sir Morton Peto.
Sir John Hay.	The Marquis of Hartington.
Captain Jervis.	

Mr. *T. G. Baring*, a Member of the Committee, examined.

[Adjourned to Thursday next, at One o'clock.

Jovis, 9° die Julii, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Captain Jervis.	Sir John Hay.
Mr. Laird.	General Peel.
Mr. Beecroft.	Sir Morton Peto.
Mr. T. G. Baring.	The Marquis of Hartington.
Colonel Dunne.	Sir Frederic Smith.
Mr. Dodson.	

Captain *Blakeley* further examined.

The Committee deliberated.

Motion made, and Question put, "That the Plan, No. 58 a, of Appendix, produced by the witness, Captain Blakeley, be expunged"—(Sir *John Hay*).—The Committee divided:

Ayes, 4.	Noes, 3.
Captain Jervis.	Mr. Laird.
Mr. Baring.	Mr. Beecroft.
Colonel Dunne.	Mr. Dodson.
Sir John Hay.	

Mr. *Anderson*, Marquis of *Hartington*, Mr. *Whiffen*, and Lieutenant Colonel *Boxer*, severally further examined.

[Adjourned to Thursday next, at Twelve o'clock.

Jovis, 16° *die Julii*, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Captain Jervis.	Mr. Vivian.
Mr. Beecroft.	The Marquis of Hartington.
Mr. T. G. Baring.	Colonel Dunne.
Mr. Dodson.	Lord Robert Cecil.
General Peel.	Sir Morton Peto.
Mr. Laird.	

The Committee deliberated.

Draft Report proposed by the Chairman, read 1°, as follows:—

"1. YOUR Committee have taken into consideration the evidence given before the Ordnance Committee of last Session, and have themselves examined witnesses.

"2. As almost the whole of the expenditure they have inquired into has been made upon Armstrong guns and ammunition, it is necessary to commence with a short history of the introduction of that system of ordnance into Her Majesty's service.

"3. It appears that Sir William Armstrong was, in 1855, authorised by the Secretary of State for War to construct one or more guns, not exceeding six, according to a suggestion he had made of the expediency of enlarging ordinary rifles to the standard of field guns, and using elongated lead projectiles. Authority was also given to him to make the necessary experiments in connection with the subject. Acting on this authority, he constructed a 3-pounder, which was delivered in July 1855, and afterwards supplied other guns in 1857 and 1858. App., p. 158, 1862.

"4. In 1858 the attention of General Peel, who had just accepted the office of Secretary of State for War, was directed to the circumstance that we were behind other countries in not having any rifled ordnance in our service. He accordingly called upon Colonel Lefroy, his scientific adviser, for a report on all the experiments that had been tried on rifled ordnance; and in accordance with the recommendation of that report, appointed a special Committee to advise him as to what was the best rifled gun for field service. This special Committee, after analysing the reports in the possession of the War Department on the various rifled guns which had been submitted to the Select Committee, came to the conclusion that it was not expedient to incur the expense of trying further experiments with any except those of Messrs. Whitworth and Armstrong. They proceeded, therefore, to try the Whitworth and Armstrong guns. 2308. App. No. 3.

"5. It appears from the report that the experiments with the Whitworth gun were of a very partial character. Those with the Armstrong gun were more extended. It must be observed that 12 and 18-pounder Armstrong guns were tried against a 9-pounder Whitworth gun; but at that time Mr. Whitworth had not any larger gun ready for trial. Indeed, he had not any gun of his own construction. He simply had rifled Government blocks of brass and cast-iron. It was then decided to adopt the Armstrong field gun into the service, and a guarantee was given to Sir W. Armstrong that he should not be a loser by the expenditure of 12,000 *l.* on a plant sufficient to enable him to turn out 100 guns a year. 3977. 3105. 2312.

"6. This guarantee was afterwards increased; but Lord Derby, in a letter addressed to General Peel on the 18th of December 1858, said that he should rather doubt the expediency in the present infancy of the invention, and when doubtless time and experience will both suggest improvements and produce economy in manufacture, of pressing for the immediate supply of a large number of guns, of the first type and at the highest rate. He also suggested that the first orders should be confined chiefly, if not exclusively, to that class of guns, say 32-pounders, of which we have had sufficient proof, and that we should defer any order for heavier guns till they had been rather more tested.

"7. On the 15th of January 1859, Sir W. Armstrong assigned his interest in all patents for and improvements in the manufacture of ordnance to the Government.

"8. The Secretary of State for War has declined to submit these patents to your Committee, on the ground that he is disposed to think that it would be contrary to public policy to do so. 5078.

"9. Sir W. Armstrong has himself stated that he never cared for or attached any value to the patent; and Mr. Anderson said that there was no secret in the patent; and that he thinks that keeping the patent secret is of no value whatever. 5010. 5555.

"10. In order to obtain as soon as possible a sufficient supply of Armstrong guns, it was decided to supplement the resources of Woolwich by entering into arrangements with a company set up at Elswick for the manufacture of Armstrong guns and projectiles; a

guarantee was given to this company on the 16th January 1859, to secure them against loss, by the erection of buildings and machinery. The Government undertook to keep them in full work, but kept in its own hands the power of terminating the engagement on the payment of compensation.

5031. "11. Since the appointment of your Committee the agreement has been terminated, and 85,000 *l.* has been paid to the Company. Lord de Grey states, that value of over 19,000 *l.* in stores has been received. This would make the amount paid as compensation about 65,000 *l.*

"Sir W. Armstrong was, on the 22d of February 1859, appointed engineer of rifled ordnance. The most important of the duties of that office were to conduct all experiments and investigations which might be sanctioned by the War Department for the purpose of developing his system, or for the improvement of rifled ordnance generally, and to report and advise upon all questions submitted to him by the War Department, in relation to
App. No. 3, p. 179. rifled ordnance. At a subsequent period he became also superintendent of the Royal Gun Factory, in the place of Colonel Eardley Wilmot, R. A. This was the first time that that office had been held by a civilian. Since the appointment of your Committee, Sir W. Armstrong has resigned these offices, and has ceased to be an officer of the Government.

"13. On the 24th of September 1859, a Committee, of which Sir William Armstrong was a member, approved of the adoption of the Armstrong 40-pounder into the naval service. They also approved of Sir William Armstrong's proposal to construct a nine-inch
App. No. 3, p. 176, 1862. gun of 130 cwt. Sir William Armstrong in his evidence, in reply to the question upon what series of experiments the 110-pounder was approved, answered, 'None at all. There
3549. was such an excessive pressure for rifled guns into the service, there was no time for
5178. experiments.' The Duke of Somerset said that he dared say this answer was substantially correct with respect to the 110-pounder gun; our only experiments were with the 40-pounders.

"Thus we became exclusively committed to the Armstrong system. Colonel Lefroy has stated that he did not think Mr. Whitworth has had the same opportunity of having experiments tried with his guns that Sir W. Armstrong has—because Sir W. Armstrong is
354. the engineer for rifled ordnance to the Government. The Government has adopted deliberately his system of rifling, and is bound to work it out. This remark applies, of course, with equal force to all other inventors.

4714. "14. It appears that the French and other foreign Governments have not committed themselves thus to any new system, but have adopted the cheaper course of making provisional arrangements for meeting the want of rifled guns, while they are bringing science and experiment to bear on the investigation of the whole question. This has been done by strengthening and rifling ordnance already in their possession. It was considered by the Government whether we should adopt a similar course. Lord Herbert took great interest in the question, and directed experiments to be made to solve it, but the Admiralty in the autumn
5233. of 1860 wrote to the War Office, saying most decidedly, after having perused the report of the Ordnance Select Committee, that they were not of opinion that the (strengthened) iron guns could be introduced into the naval service with safety.

"15. Your Committee have already stated that the whole supply of Armstrong guns and projectiles were made by the Royal Arsenal at Woolwich, and by the Elswick Ordnance Factory. A return furnished by Mr. Whiffin shows:—

App. 44, Paper. "1st. That the sum of 965,117 *l.* 9 *s.* 7 *d.* has been paid to the Elswick Ordnance Company for articles supplied.

"2d. That the sum of 70,295 *l.* 8 *s.* has been paid to the Elswick Ordnance Company as compensation for terminating the contract.

"3d. That the outstanding liabilities of the War Office to the Elswick Ordnance Company for articles ordered amounts to the sum of 37,143 *l.* 2 *s.* 10 *d.*

"4th. That 14,704 *l.* 12 *s.* has yet to be paid to the Elswick Ordnance Company to complete the sum awarded as compensation for the termination of the contract.

"(Since this return was submitted to your Committee, the transactions between the Elswick Company and the War Office have been wound up. The Elswick Company have received 85,000 *l.*, and the Government have got stores at the stated value of upwards of 19,000 *l.*)

"The whole of these payments and liabilities amounts to the sum of 1,087,260 *l.* 12 *s.* 5 *d.*

App. 5, p. 207. "5th. That the sum of 1,471,753 *l.* 1 *s.* 3 *d.* has been expended in the three manufacturing Departments on the Armstrong guns, ammunition, and carriages, making altogether a grand total of 2,559,013 *l.* 13 *s.* 8 *d.*, and to this must be added the sum 25,897 *l.* 18 *s.* 6 *d.* for cast-iron guns specially cast for the reception of hoops, after the design of Sir William Armstrong.

"16. This return professes further to show that taking the class of stores which have been supplied from Elswick and from Woolwich, and which therefore admit of a direct comparison, the sum of 227,173 *l.* 10 *s.* 6 *d.* would have been saved to the public had these guns, projectiles, and fuzes, supplied by the Elswick Ordnance Company been manufactured

tured in the Royal Arsenal. Assuming this comparison to be a fair one, and that the same per-centage of saving would have been effected on those articles in regard to which no direct comparison can be made, because none have been manufactured in the Arsenal, the public would have been benefited to the extent of 494,112 *l.* 13 *s.* 3 *d.*, had advantage been taken of the Arsenal establishment for the supply of Sir W. Armstrong's guns, projectiles and fuzes, independently of the additional expense which Captain Gordon states was incurred on account of packing cases, &c., connected with the supplies from the Elswick Ordnance Company.

" 17. It has been suggested that the accounts on which this return is founded have not been kept on commercial principles, and omit various charges which ought in fairness to be included in them; opinions widely differing from one another as to the mode in which contingencies should be estimated and charged have been expressed. 2557–2560.

" 18. The conflicting views on these subjects were ably stated by Mr. Baring on the one hand, and Lieutenant Colonel Boxer, R.A., and Mr. Whiffin on the other, in their evidence of the 5th and 9th of this month. See also letters of Elswick Ordnance Company, and replies by Messrs. Anderson and Whiffin.

" 19. It will be observed that Mr. Whiffin states that, after thoroughly investigating the matter, he is satisfied with the substantial accuracy of the comparison he has made; and Colonel Boxer, that there is no doubt in the world about it. 5575–6–7. 5706. 5716.

" 20. When the Armstrong and projectiles were introduced into the service, the question to be solved was not at what cost these articles would have been manufactured by the Government if they had been obliged to purchase land, to erect factories upon it, to construct them *de novo*, and furnish them with completely new machinery. The War Office had at its disposal large establishments erected for the manufacture of other sorts of ordnance, brass and iron; they had determined to manufacture no ordnance except upon the Armstrong system. Their establishments must, therefore, have remained idle, paying taxes and requiring to be maintained had they not been adapted to the new system of manufacture; they were so adapted with the intention of manufacturing a portion of the supply required.

" 21. At a cost of 1,000 *l.* for special machinery the Royal Laboratory could have produced all the ammunition and projectiles which was distributed between it and Elswick. 5720.

" 22. For a sum not much exceeding that which has been paid as compensation to the Elswick Ordnance Company, the Royal Gun Factories could have been made capable of producing all the guns made at Elswick in addition to those which it supplied. 5515–16–29–46.

" 23. It has been suggested that at the time of the manufacture of the first guns on the Armstrong principle, they could not have been made at Woolwich. This is probably true, so far as the experimental guns ordered in 1858 are concerned. It has been shown that, without Sir William Armstrong's assistance, it would not have been possible to carry out his system, and without a guarantee, he could not have been expected to provide the buildings and machinery necessary to carry it out. But when he became officially connected with the War Office, and when his guns were adopted into the service, your Committee are unable to comprehend why, with his able assistance, Woolwich might not have been as easily and promptly adapted for the intended object as Elswick was constructed for it.

" 24. It has been said that the competition with Elswick promoted economical manufacture at Woolwich. Your Committee have not learned that the articles which were exclusively manufactured there were manufactured less carefully, or with less regard to economy than those of which a portion were made at Elswick. 5505–6–7–20. 5722.

" 25. Lord de Grey said that he thought the guarantee given by the agreement with the Elswick Ordnance Company was a part of the general arrangement by which the patent of Sir William Armstrong, and his services also to the Government, were obtained; but as Sir William Armstrong has stated that he had no share or interest in that concern, your Committee are unable to understand how any contract with it, or guarantee given to it, can have been an element in negotiations conducted with him. 5062.

" 26. The real justification for the contract in question seems to have been that, on the one hand, it was at first very difficult without experiment to estimate with any accuracy the probable cost of production at Woolwich; and, on the other hand, the pressure for the rapid production of rifled ordnance, which rendered it difficult to wait until experiments in production were tried.

" 27. It is easy to criticise after the event, and to find fault with proceedings which, at the time they were entered upon, seemed politic and reasonable.

" 28. Your Committee have received various and most conflicting evidence with regard to the results of this large expenditure.

" 29. It has been shown that the whole amount expended on guns, as distinguished from projectiles and ammunition has been thus distributed:

5700.

On 12-pounders	56,193
„ 40-pounders	221,567
„ 70-pounders	33,496
„ 110-pounders	463,383
„ 300-pounders	14,600
„ 600-pounder	4,000

" The 12-pounders, although stated by some of the witnesses to be too complicated a weapon for service, are generally approved of.

1217. " 30. His Royal Highness the Duke of Cambridge thinks that, with our present experience, we have as good a weapon as we can expect to have, but cannot say that it is a perfect weapon; on the other hand, Sir Richard Dacres, who commanded our artillery at 2185. the siege of Sebastopol, although he considers it the best rifled gun known, thinks it has a great many defects, and would not consider it safe to rely entirely upon it for field service. Colonel Bingham, who, on the whole, agrees with the Commander in Chief, attributes certain 368. failures complained of in the guns to bad manufacture.

" 31. It must be remarked that the chief defect complained of was, that the guns were 334. patched up or lined, but it appears that the sealed pattern given at Woolwich was a lined 550. gun. This gun was sealed upon the recommendation of the Select Committee. Mr. Anderson, in reference to Colonel Bingham's statement, that half the field guns in the 567. service are unserviceable, says, To bring the 1863 knowledge as a standard to test the guns of 1859, would not be fair. He does not think much of those guns now; the guns of 1861 are better than those of 1859; those of 1862 than those of 1861. From his present knowledge, he thinks the guns of 1862 very bad in many particulars. He positively 548. 568. denies that the lining complained of by Colonel Bingham was the cause of the failure of the guns.

1561. " 32. Upon the 40-pounders, Your Committee have not received much evidence. Captain Cooper Coles' evidence with reference to them is of considerable importance, but it must be remarked that Sir W. Armstrong and General Tulloh consider that the new pattern vent-pieces will prevent the recurrence of such accidents as Captain Coles details. The accounts of various experiments with these guns will be found in the reports from Her Majesty's ships " Excellent," " Cambridge," and " Emerald," contained in the Appendix.

" 33. As to the 110-pounder, it is on all hands admitted that although useful as chase guns, they ought not generally to be introduced into the naval service. Your Committee have already stated that no series of experiments took place with the 110-pounder before it was approved and a large number ordered to be supplied.

5109. " 34. The Duke of Somerset states that we have nothing better now for close quarters than the 68-pounder, and concurs with all the naval witnesses in considering that while in the armament of Her Majesty's ships only a small proportion of the 100-pounders should be included; they are most valuable for chase and pivot guns. His Grace further adds that it was not till he tried a 100-pounder and a 68-pounder against Captain Coles' cupola, that he 5108. became aware that the 68-pounder struck a harder blow than the 100-pounder at short range.

" It should be observed that this comparison was made when the charge of the 100-pounder was 14 lbs.; it has now been reduced to 12 lbs.

5102. " 35. The Duke of Somerset further informed Your Committee that the Admiralty had a report that the Armstrong gun had the greatest range and the greatest power of penetration of any gun tried; when they came to try it themselves, that was not confirmed by the facts; the Armstrong gun at a great distance may have had greater power of penetration, but for naval purposes at 200 yards, it certainly had not the greatest power; our old 68-pounder is a more powerful gun than the 100-pounder Armstrong gun.

The old 68-pounder is therefore the most effective gun in the service against iron plates.

3661. " 36. Captain Jerningham, whose evidence is favourable to the Armstrong smaller guns, including the 40-pounder, says, that when he went to Woolwich and saw the hundreds of 100-pounder guns lying about there, manufacturing and being issued, it used to strike him that we were going on rather too fast in laying out so much money on those big guns before they were completed. When asked, " Do you mean before the idea was complete with respect to the whole gun?" he replies, " especially with respect to the vent pieces; if he gets over that difficulty, Sir W. Armstrong has almost gained his point."

3163. " 37. As to the principle of constructing his guns of coiled iron tubes, Sir W. Armstrong states that he began with 3-pounders of 5 cwt., and has ascended step by step to 600-pounders of 22 tons, and that the safety of this principle has, he considers, been established by the fact, that out of nearly 3,000 guns, no one gun has burst explosively; and, in fact, no one gun has failed under the most trying tests, excepting by a gradual process.

8. 131. 175. 327. 1232. 1568. 2166. 2184. " 38. While almost every witness has borne testimony to the superior accuracy and range of the Armstrong guns, great doubts have been expressed as to whether they are not too delicate a weapon, and too liable to get out of order to be entirely relied upon in actual warfare.

warfare. It must be remarked, however, that the officers who commanded Armstrong batteries in the late operations in China, found no difficulty in keeping them in order in all weathers, and under all circumstances. 8. 3209, 2184, 3802. 2299. App. 46.

" 39. The testimony as to the Armstrong shell has been universally favourable as the most destructive weapon ever used against wooden ships, and most formidable in its effects and range. 3130.

" 40. The fuzes have always been uncertain, and have been condemned.

" 41. As to the principles involved in the Armstrong system, your Committee can only refer to the scientific evidence given before them. The preponderance of opinion seems to be against the breech-loading system for larger guns.

" 42. No sufficient experiments have been tried to show whether mechanical fitting projectiles are liable to the objections made against them by Sir W. Armstrong and others that they must destroy the gun from which they are fired. The shunt system by which it is attempted to have muzzle-loading guns rifled without mechanical fitting projectiles is still an experiment.

" 43. Without expressing any opinion on these controverted questions your Committee venture to express a hope that, without prejudice or partiality, the different systems, not of Sir W. Armstrong and Mr. Whitworth only, but of Mr. Bashley Britten, Captain Blakeley, Mr. W. Richards, and the other able men whose minds are now engaged on ordnance questions, may be fairly experimented upon.

" 44. No trials can be altogether satisfactory to which, under proper restrictions, the scientific public are not admitted. Neither can systems fairly compete with one another unless the guns manufactured according to them are made with equal skill, and with, in every case, the best available materials.

" 45. Your Committee are convinced that no reasonable expenditure for accomplishing these objects would be refused by you, and the present interruption of the manufacture of Armstrong guns at Woolwich affords a good opportunity for devoting the resources of that establishment to promoting these experimental purposes."

Draft Report proposed by Captain Jervis, read 1°, as follows:—

" Your Committee having investigated the subject referred to them, have agreed to the following Report:—

" 1. Your Committee have considered the evidence given before the Ordnance Committee last Session, and have taken evidence during the present Session.

" 2. They find that the expenditure on improved Ordnance since 1858 has been chiefly devoted to the production of Armstrong guns and ammunition.

" 3. From the evidence of General Peel, a Member of your Committee, it appears that in 1858, at the period of his accepting office as Secretary of State for War, it was most material to the interests of the country that a rifled gun should at once be introduced for service in the field. Ordnance Report, 1862, Q. 2308.

" 4. A Special Committee of scientific officers was appointed to inquire and report as to what was then the best rifled gun. Their report was unanimously in favour of Sir W. Armstrong's system, which was in fact the only complete system submittted to them. Ordnance Report, 1862, App. 3.

" 5. Experiments carried out with a view of rifling the large cast-iron guns of the service having completely failed, the late Lord Herbert ordered Sir W. Armstrong to extend his system at once to guns of large calibres for the armament of ships and fortresses. Lord De Grey, 5048–49. Mr. Baring, 5233. Col. Lefroy (1862), 177. Lord De Grey, 5059.

" 6. At the same time careful and extensive experiments were carried on to test whether any safe system of strengthening cast-iron guns could be found, or whether any better, speedier, or cheaper system of constructing rifled guns existed than that proposed by Sir W. Armstrong. None such having been found within the period for inquiry, the Armstrong system was completely adopted by the Government for rifled ordnance of all calibres. Mr. Baring, 5230. 5233–34. Colonel Lefroy (1862), 177, *et seq.* General St. George (1862), 2763. 2765. Ordnance Report (1862), App. 3, p. 207. Report of Ordnance Select Committee on Cast Iron Ordnance, 1863.

" 7. It appears to your Committee that the Armstrong field gun is the best known for field purposes. His Royal Highness the Field Marshal Commanding in Chief states that, in his opinion, Sir W. Armstrong's system surpasses in completeness any other, and his conviction is that England in this respect is ahead of any other country. Colonel Bingham, Adjutant General of Artillery, states, that he is perfectly satisfied with the Armstrong field gun, that it is the best gun known, and that this is the general opinion of officers of artillery of all classes. Duke of Cambridge, 1250, 1251. Colonel Bingham, 374, 375. 524. 534.

" 8. The attention of Your Committee was drawn to the failure of some of these field guns. This appears to have arisen, not from any defect in the system, but from faulty manufacture. On careful investigation, Your Committee find that out of 570 12-pounders issued Duke of Cambridge, 1219. App. 8 (1863). Colonel Bingham, 368.

Sir W. Armstrong, 3605. App. 1863, No. 55. Anderson, 613. Sir W. Armstrong, 3863. 8867.

issued and in use, 13 only have been returned to the Royal Gun Factories for repair, three of which have proved unserviceable, and the remainder repairable at an inconsiderable expense.

Duke of Somerset, 5126. 5128. Captain Hewlett, 3272. Captain Jerningham, 3633. 3646. 3734.

" 9. The success which attended the field guns on the Armstrong principle has been extended to some of the larger calibres, and the 20-pounder and 40-pounder guns appear to give general satisfaction.

Sir W. Wiseman (1862), 178.

" 10. Considerable difference of opinion exists, however, as to the 110-pounder.

Lord De Grey, 5050. 5089. Duke of Somerset, 5226.

" 11. The political necessities of the time appear to have precluded the maturing of the design for this calibre of gun previous to its manufacture, and it appears questionable whether the screw system of breech loading should have been extended to guns of such calibre.

Duke of Somerset, 5156. Earl of Lauderdale, 2159. Admiral Dacres, 3188. Captain Cochrane, 2268.

" 12. They were originally required for use against wooden ships, and, whilst not sufficiently powerful for penetrating iron-plated ships, are as yet imperfect for general naval service, owing to the difficulty of managing and manufacturing the vent-piece.

Duke of Somerset, 5136. Admiral Dacres, 3174. Captain Hewlett, 3274. Captain Cochrane, 2233. Captain Ewart, 4554. Duke of Somerset, 5157. 5183.

" 13. Nevertheless the 110-pounder is considered by naval men of eminence in their profession as a most valuable weapon in its present proportion to the armament of a ship, and the Duke of Somerset is of opinion that the Navy has not got too many of them.

" 14. The Armstrong 110-pounder having been found insufficient, and as yet imperfect, your Committee proceeded to inquire whether any alternative system of ordnance exists which, with an equal expenditure, might have yielded better results. With this object, they have examined Mr. Whitworth, Mr. Westley Richards, and other gentlemen whose attention has been occupied with questions of ordnance improvements.

" 15. After considering the evidence of these witnesses, your Committee are of opinion that no system of rifled ordnance has yet proved itself equal to the Armstrong system. As to construction, the only distinct alternative method is that proposed by Mr. Whitworth, which has as yet been only partially carried into effect. As to rifling, your Committee find no method which has as yet proved itself superior in general efficiency to that employed by Sir W. Armstrong.

Mr. Baring, 5397, 5398. Jerningham, 3633. Cochrane, 2236. Ordnance Report, 1862, App. 5; 1863, App. 35.

" 16. The evidence taken by Your Committee with respect to the Armstrong projectiles is universally favourable. The shell is described as the most destructive missile ever known for use in the field, or against wooden ships, and earth and brickworks. The arrangement by which the compound projectiles for field service is rendered at any moment convertible into solid shot, shell or shrapnell, is of the highest value and importance.

Captain Hewlett, 3294. 3296.

" 17. The Armstrong fuzes are of various kinds; and although the naval time fuze is still unsatisfactory, they form, as a whole, a valuable accessory to the system.

" 18. Your Committee having satisfied themselves that the Armstrong system of ordnance and ammunition has proved itself a satisfactory subject for the expenditure on improved ordnance since 1858, have further inquired whether that expenditure has been excessive.

Lord De Grey, 5050, 5089. Colonel Lefroy, Ordnance Report, 1862, 208.

" 19. They find that, allowing for the novelty of the manufacture, the great pressure for guns and ammunition, and the frequent changes of pattern caused by the necessity to manufacture guns before designs were matured or experiments concluded, the expenditure has not been excessive.

Ordnance Report, 1862, App.

" 20. A considerable portion of this expenditure has been incurred for guns and projectiles supplied by the Elswick Ordnance Company under an agreement with the Government.

" 21. Your Committee have, therefore, investigated the origin and nature of that agreement.

Ordnance Report, 1862. General Peel. Ordnance Report, 1862. App. No. 11. Ordnance Report, 1862. General Peel, 2312. Clode, 2368.

" 22. It appears, from the evidence of General Peel, that upon the adoption of the Armstrong gun, he asked Sir W. Armstrong, then a member of a manufacturing firm at Elswick, near Newcastle, upon what terms, and how speedily, he could manufacture a small number of his guns for the service. Sir W. Armstrong replied, that, in contemplation of an urgent order for guns, the Elswick Company had already laid out 14,000 *l.* on the special plant necessary for the production of the guns. Thereupon an agreement was entered into between the Government and the Company, by which the Company were guaranteed from loss upon that outlay, and were directed to supply 100 guns at prices exclusive of the cost of the plant.

Ordnance Report, 1862. General Peel, 2309.

" 23. In the meantime Sir W. Armstrong presented his patents to the Government, and entered their service, separating himself altogether from the Elswick Ordnance Company.

Ordnance Report, 1862. General Peel, 2312. Clode, 2368. Ordnance Report, 1862. Clode, 2368. Lord De Grey, 5044–46.

" 24 The guarantee to the Company was then extended to 35,000 *l.*, to enable it to turn out 166 to 200 guns, instead of 100. Shortly afterwards it was further raised to 50,000 *l.*, and then to 60,000 *l.*, to enable the Company to supply both guns and projectiles. After General Peel left office, Lord Herbert, owing to the increased pressure for guns, raised the guarantee to its final amount of 85,000 *l.*

Sir W. Armstrong, 4973.

" 25. The Elswick Company laid out 180,000 *l.* in plant.

" 26. Their

"26. Their guarantee has now been concluded by a payment of 65,000 *l.* compensation. Lord De Grey, 50, 31.

"27. It has been suggested, that had the whole of the ordnance and ammunition been manufactured in the Royal Arsenal, a considerable saving would have been effected.

"28. The evidence on this subject is conflicting.

"29. On the one hand, Colonel Boxer, Superintendent of the Royal Laboratory, and Mr. Whiffin, Assistant Accountant General of the War Office, state that, assuming their comparison of the prices at Elswick and Woolwich to be a fair one, a very large saving would have accrued. Mr. Rendel and Captain Noble, R.A., on the part of the Elswick Company, object to any such comparison until the Royal Arsenal prices are ascertained on an accurate basis. Mr. Anderson, Assistant Superintendent of the Royal Gun Factory, who alone was responsible for the accounts, states that he is unable to say what is the actual comparative cost of the Royal Gun Factory guns; and Mr. Baring a Member of Your Committee, and sometime Under Secretary of State for War, is of opinion that the comparisons instituted by Mr. Whiffin between the Elswick prices and the Woolwich rates is not reliable.

Ordnance Report, 1862.
Anderson, 1334. 1362.
Baring, 5300.
Anderson, 5484. 5478–89.

"30. Looking to the necessity for the application to the Elswick Company in the first instance, and to the fact that for two subsequent years both the Royal Gun Factory and the Elswick Works were employed to extremity, and having regard to the advantages which have accrued to the country from the maintenance of separate factories under rival management, whereby the productive power of each has been stimulated, and the prices of each reduced, Your Committee find themselves unprepared to impugn the wisdom of the course adopted by General Peel, and acquiesced in by succeeding administrations with respect to the Elswick Company, nor are they prepared to say that the prices paid to the Elswick Company have been other than fair and reasonable."

Anderson, 5502.
Lord De Grey, 5088–89.

Lord De Grey, 5064. 5043. 5086.

Motion made, and Question put, "That the Committee do now adjourn to Monday next, at Twelve o'clock"—(Colonel *Dunne*):—The Committee divided:

Ayes, 5.	Noes, 6.
Mr. Baring.	Mr. Beecroft.
Colonel Dunne.	Lord Robert Cecil.
Marquis of Hartington.	Mr. Dodson.
Captain Jervis.	Mr. Laird.
General Peel.	Sir Morton Peto.
	Mr. Vivian.

Motion made, and Question put, "That the Evidence be reported to the House, with a recommendation that the Committee be re-appointed at the beginning of next Session, for the purpose of reporting upon it"—(Lord *Robert Cecil*):—The Committee divided:

Ayes, 5.	Noes, 6.
Mr. Beecroft.	Mr. Baring.
Lord Robert Cecil.	Mr. Dodson.
General Peel.	Colonel Dunne.
Sir Morton Peto.	Marquis of Hartington.
Mr. Vivian.	Captain Jervis.
	Mr. Laird.

Motion made, and Question put, "That the Report proposed by the Chairman be now read 2°, paragraph by paragraph"—(*The Chairman*).—Amendment proposed, to leave out the words "The Chairman," in order to insert the words "Captain Jervis"—(Captain *Jervis*)—instead thereof.—Question put, "That the words 'the Chairman' stand part of the Question:"—The Committee divided:

Ayes, 6.	Noes, 5.
Mr. Beecroft.	Mr. Baring.
Lord Robert Cecil.	Colonel Dunne.
Mr. Dodson.	Marquis of Hartington.
Mr. Laird.	Captain Jervis.
Sir Morton Peto.	General Peel.
Mr. Vivian.	

Main Question put, and agreed to.

The Committee deliberated.

[Adjourned to Monday next, at Eleven o'clock.

Lunæ, 20° *die Julii*, 1863.

MEMBERS PRESENT.

Mr. MONSELL in the Chair.

Captain Jervis.	Colonel Dunne.
Sir John Hay.	Sir Morton Peto.
General Peel.	Mr. Beecroft.
Sir Frederick Smith.	Marquis of Hartington.
Mr. T. G. Baring.	Mr. Dodson.
Mr. Vivian.	Lord Robert Cecil.
Mr. Laird.	

Paragraphs 1 and 2, agreed to.

Paragraph 3.—Amendment proposed, to leave out from the word "That," in line 1, to the end of the paragraph, in order to add the words:—"The Armstrong gun was first brought to the notice of the Government in December 1854, when the Duke of Newcastle (then Secretary of State for War) gave Sir W. Armstrong (then Mr. Armstrong) an order for a number of his guns, not exceeding six, for trial.

App., p. 158, 1862.

14 July 1855. 027—85.

"The first of these guns, a three-pounder, was delivered in July 1855, when Mr. Armstrong forwarded a detailed Report (A. annexed) of the experiments he had made, and of the principle of the construction of his gun and projectiles. The whole subject was referred to the Ordnance Select Committee, who reported, in the main, favourably of the gun, though qualified, and desired to make further experiments.

29 November 1855. 027—272.

30 December 1856. 136 A.—40½.

"The gun was re-bored up to a 5-pounder, and, in December 1856, was tried in the presence of Colonel Eardley Wilmot (Superintendent, Royal Gun Factory), near Newcastle, who reported, 30th December 1856, that at 1,500 and 2,000 yards, the gun had made remarkably good practice.

31 January 1857. 136 A.—40½. 80—A—12. .—19. .—23. 5 February 1858. —31. 22 February 1858.

"In January 1857, a second gun was ordered, to correspond as nearly as possible with the service 9-pounder field gun. This gun, an 18-pounder, was reported ready on 1st July 1857, and the programme of the trial arranged 14th October; but the trial was delayed, owing to Mr. Armstrong's absence on the continent, until 26th January 1858, when experiments were made with it in competition with a service 32-pounder gun, which were reported by the Ordnance Select Committee, 5th February 1858.

"The result was so satisfactory that Lord Panmure expressed himself thus:—'I am clearly of opinion that this is a most valuable contribution to our army. For all purposes of projection and accuracy of flight of the projectiles, the experiments are conclusive; and we should have two more guns made of the same size as that which has been tried at Shoeburyness, one of which may be without the recoil slide, and they should be handed over to the artillery to knock about, and be reported upon as to their endurance of work in comparison with our service guns.'

9 February 1858, 80—A—32.

"Colonel Mitchell made a further report on this trial, detailing further experiments which he desired might be made.

25 February. 13 April.— 39 and 36.

"On 25th February two 18-pounder guns were ordered, and on 13th of April one 12-pounder, and 400 projectiles for the 18-pounders, were ordered for further experiments"—(Captain *Jervis*)—instead thereof.—Question, "That the words proposed to be left out stand part of the paragraph," put, and negatived.—Words added.

Another Amendment proposed, "That the words 'a full description of the first gun supplied by Sir William Armstrong to the Government will be found in his Report dated the 14th July 1855'"—(Sir *Frederick Smith*)—be added at the end of the last Amendment.—Question, That those words be there added—put, and agreed to.—Paragraph, as amended, agreed to.

Paragraph 4, agreed to.

Paragraph 5.—Amendment proposed, to leave out from the word "appears" to the word "indeed," in line 4, in order to insert the words: "that the experiments with the Whitworth gun were not of as extended a character as those with the Armstrong gun. Your Committee are of opinion that the adoption of the latter by the Secretary of State for War for special service in the field was fully justified"—(General *Peel*)—instead thereof.

Question, "That the words proposed to be left out stand part of the paragraph," put, and negatived.

Question proposed, "That those words be inserted instead thereof."—Amendment proposed to the said proposed Amendment, by leaving out from the word "that" to the words "Your Committee," in order to insert the words "from the papers laid before your Committee, it appears that 91 rounds only were fired from the brass 9-pounder howitzer of the service pattern rifled by Mr. Whitworth to carry a 12-pounder elongated projectile, and that upon this superficial trial, a system of rifling which, when applied to small arms, has proved itself of high excellence, and which offered a ready solution to the difficulty of loading rifled ordnance from the muzzle, was condemned. Trials were made with a cast-iron

naval

naval gun rifled by Mr. Whitworth, which, on the 8th October 1858 (Appendix 28, page 11), pierced the iron plates of the 'Alfred' 4½ inches thick; the gun subsequently burst, and thus shared the fate of all cast-iron rifled guns hitherto tried in this country. No attempt appears to have been made to construct guns on this system of adequate strength to resist the strain due to rifling until a recent date, when the country was practically committed to the Armstrong system. Your Committee regret that more effective trials of these two systems of rifling were not made prior to the complete committal of the country to one system"—(Mr. *Vivian*)—instead thereof.—Question put, "That the words proposed to be left out stand part of the said proposed Amendment:"—The Committee divided:

Ayes, 7.	Noes, 5.
Mr. Baring.	Mr. Beecroft.
Mr. Dodson.	Mr. Laird.
Colonel Dunne.	Sir Morton Peto.
Marquis of Hartington.	Sir F. Smith.
Sir John Hay.	Mr. Vivian.
Captain Jervis.	
General Peel.	

Another Amendment proposed to the said proposed Amendment, by inserting after the words "Armstrong gun," the words "At that time Mr. Whitworth had not any gun of his own construction, nor did he propose any system of constructing guns. He had only rifled Government blocks of brass and cast iron. The system proposed by Mr. Armstrong was therefore the only complete one before the Committee"—(Mr. *Baring*).—Question, "That those words be there inserted," put, and agreed to.

Another Amendment proposed, to the said proposed Amendment, by inserting after the last Amendment, the words: "On the other hand, Mr. Armstrong proposed a method of constructing a gun which rendered it capable of enduring the strain to which rifled ordnance is submitted. This method was certainly at that time the only one capable of fulfilling that condition, and your Committee have had no practical evidence before them, that even at this moment any other method of constructing rifled ordnance exists which can be compared to that of Sir W. Armstrong. In combination with his system of constructing or manufacturing a gun, Sir W. Armstrong had introduced to the notice of the Government a plan of breech-loading, the gun being rifled on the old polygroove system, which involved the coating of the projectile with soft metal. This combination of construction, breech-loading, rifling and coating the projectiles with soft metal came to be viewed as the Armstrong system. The range and precision of the gun were so vastly superior to all field ordnance known at that time, that after careful and repeated trials, the Committee appointed to investigate the question recommended its adoption as the field gun of the service"—(Mr. *Vivian*).—Question, "That those words be there inserted," put, and agreed to.

Question, That the words "that the experiments with the Whitworth gun were not of as extended a character as those with the Armstrong gun. At that time Mr. Whitworth had not any gun of his own construction, nor did he propose any system of constructing guns. He had only rifled Government blocks of brass and cast-iron. The system proposed by Mr. Armstrong was therefore the only complete one before the Committee On the other hand, Mr. Armstrong proposed a method of constructing a gun which rendered it capable of enduring the strain to which rifled ordnance is submitted. This method was certainly at that time the only one capable of fulfilling that condition, and your Committee have had no practical evidence before them, that even at this moment any other method of constructing rifled ordnance exists which can be compared to that of Sir W. Armstrong. In combination with his system of constructing or manufacturing a gun, Sir W. Armstrong had introduced to the notice of the Government a plan of breech-loading, the gun being rifled on the old polygroove system, which involved the coating of the projectile wth soft metal. This combination of construction, breech-loading, rifling and coating the projectiles with soft metal, came to be viewed as the Armstrong system. The range and precision of the gun were so vastly superior to all field ordnance known at that time, that after careful and repeated trials, the Committee appointed to investigate the question recommended its adoption as the field gun of the service" be inserted after the word "appears" in the paragraph,—put, and agreed to.—Further Amendments made.—Paragraph, as amended, agreed to.

Paragraph 6—Amendments made.—Question put, "That this paragraph, as amended, stand part of proposed Report:"—The Committee divided:

Ayes, 5.	Noes, 5.
Mr. Beecroft.	Mr. Baring.
Mr. Laird.	Colonel Dunne.
Sir M. Peto.	Marquis of Hartington.
Sir F. Smith.	Captain Jervis.
Mr. Vivian.	General Peel.

Whereupon the Chairman declared himself with the Ayes.

Paragraph 7, agreed to.

Paragraph 8.—Amendment proposed, to leave out the words "do so," in order to insert the words, "produce patents of this description"—(Marquis of *Hartington*).—Question put, "That the words 'do so,' stand part of the paragraph,"—put, and negatived.—Question, "That the words 'produce patents of this description,' be there inserted"—put, and agreed to.—Paragraph, as amended, agreed to.

Paragraph 9—Question put, "That this paragraph stand part of the proposed Report:"—The Committeedivided:

Ayes, 3.	Noes, 8.
Mr. Beecroft.	Mr. Baring.
Mr. Laird.	Lord Robert Cecil.
Sir Morton Peto.	Colonel Dunne.
	Marquis of Hartington.
	Captain Jervis.
	General Peel.
	Sir Frederick Smith.
	Mr. Vivian.

Paragraph 10.—Amendments made.—Amendment proposed, to add the words "The necessities of the service requiring a larger number of the Armstrong guns to be provided than were at first anticipated. The guarantee given by Lord Derby's government was increased first to 50,000 *l.* and then to 60,000 *l.* After General Peel left office, Lord Herbert, in October 1859, owing to the increased pressure for guns, raised the guarantee to its final amount of 85,000 *l.*"—(Captain *Jervis*) at the end of the paragraph, as amended.—Question, That those words be there added—put, and agreed to.—Paragraph, as amended, agreed to.

Paragraph 11.—Amendment proposed, to leave out the words, "since the appointment of your Committee"—(Captain *Jervis*).—Question put, That those words stand part of the paragraph:—The Committee divided:

Ayes, 5.	Noes, 6.
Mr. Beecroft.	Mr. Baring.
Mr. Laird.	Lord Robert Cecil.
Sir Morton Peto.	Colonel Dunne.
Sir Frederick Smith.	Marquis of Hartington.
Mr. Vivian.	Captain Jervis.
	General Peel.

Further Amendments made.—Paragraph, as amended, agreed to.

Paragraph 12, amended, and agreed to.

Amendment proposed, after paragraph 12, to insert the following paragraph: "It appears from the correspondence produced to your Committee, that in the winter of 1858–59, the Board of Admiralty, acting upon the advice of Captain Hewlett, R.N., of Her Majesty's ship 'Excellent,' gunnery ship at Portsmouth, decided upon the introduction of the Armstrong guns into the navy, for boat service; and, in the summer of the same year, the same officer having urged the importance of introducing into the navy larger calibres of Armstrong guns, the Board of Admiralty requested the Secretary of State for War, in the strongest manner, to supply them with as little delay as possible, with a large number of 40-pounder and 70-pounder Armstrong guns."—(Mr. *Baring*)—Question, That this paragraph be there inserted—put, and agreed to.

Amendment proposed, after the last paragraph (12*a*) to insert the following paragraph: "At the same time careful and extensive experiments were carried on to test whether any safe system of strengthening cast-iron guns could be found, or whether any better, speedier, or cheaper system of constructing rifled guns existed than that proposed by Sir W. Armstrong. None such having been found within the period for inquiry, the Armstrong system was completely adopted by the Government"—(Captain *Jervis*).—Question, "That this paragraph be there inserted"—put, and agreed to.

Mr. Baring, 5230. 5233–34. Colonel Lefroy (1862), 177, *et seq.* General St. George (1862), 2763. 2765. Ordnance Report (1862), App. 3, p. 207. Report of Ordnance Select Committee on Cast Iron Ordnance, 1863.

Paragraph 13.—Amendments made.—Amendment proposed, to leave out from the word "service," in line 3, to the word "thus," in line 10—(Captain *Jervis*).—Question put, "That the words proposed to be left out stand part of the paragraph:"—The Committee divided:

Ayes, 5.	Noes, 6.
Mr. Beecroft.	Mr. Baring.
Mr. Laird.	Lord R. Cecil.
Sir Morton Peto.	Colonel Dunne.
Sir F. Smith.	Marquis of Hartington.
Mr. Vivian.	Captain Jervis.
	General Peel.

Another

Another Amendment proposed, That the words: "The Armstrong system was first extended to the 110 calibre on the 14th October 1859. The political necessities of the day appear to have been so urgent as not to allow time for maturing the design previous to its manufacture"—(Captain *Jervis*)—be inserted after the word "service.," in line 3.—Question, "That those words be there inserted," put, and agreed to.

Another Amendment proposed, to add the words, "In consequence of the excessive pressure which existed at that time for the supply of guns of that calibre, the first 100 of these were constructed before any experiments upon them had been concluded"—(Lord *Robert Cecil*)—at the end of the last Amendment.—Question, "That those words be there added," put, and agreed to.

Further Amendments made—Question put, "That the words from 'Colonel Lefroy has stated,' to the end of the paragraph, stand part of the paragraph"—(The *Chairman*):—The Committee divided:

Ayes, 5.	Noes, 6.
Mr. Beecroft.	Mr. Baring.
Mr. Laird.	Lord Robert Cecil.
Sir Morton Peto.	Colonel Dunne.
Sir Frederick Smith.	Marquis of Hartington.
Mr. Vivian.	Captain Jervis.
	General Peel.

Paragraph, as amended, agreed to.

Paragraph 14.—Question put, "That this paragraph stand part of the proposed Report:"—The Committee divided:

Ayes, 3.	Noes, 7.
Mr. Beecroft.	Mr. Baring.
Mr. Laird.	Lord Robert Cecil.
Sir Morton Peto.	Colonel Dunne.
	Marquis of Hartington.
	Captain Jervis.
	General Peel.
	Sir Frederick Smith.

[Adjourned to To-morrow, at Twelve o'clock.

Martis, 21° *die Julii* 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

General Peel.	Mr. Dodson.
Captain Jervis.	Sir Morton Peto.
Colonel Dunne.	Mr. Laird.
Mr. T. G. Baring.	Mr. Beecroft.
Marquis of Hartington.	Lord Robert Cecil.
Mr. Vivian.	Sir John Hay.

Paragraph 15.—Amendments made—further consideration of paragraph postponed.

Paragraph 16.—Amendment proposed, to leave out the words "This return professes further to show that," in order to insert the words, "A statement has also been prepared by Mr. Whiffen, at the request of your Committee, showing the cost of certain guns and projectiles obtained for the Elswick Ordnance Company, compared with the rates of those produced at the Royal Arsenal, Woolwich. According to this statement,"—(Mr. *Baring*)—instead thereof.—Question put, "That the words proposed to be left out stand part of the paragraph," put, and negatived.—Question, "That those words be there inserted," put, and agreed to.

Further Amendment made.

Another Amendment proposed, to leave out from the word "Arsenal" to the end of the paragraph, in order to add the words "While in another Paper (37 of Appendix), Mr. Whiffen shows that in consequence of the contract there was a saving of 317,270 *l.* on 950 guns, being the difference between the price originally estimated, 687,700 *l.* by the Elswick Ordnance Company, and which would have been charged by contract, and the price actually paid, 370,530 *l.*,"—(Colonel *Dunne*)—instead thereof.

Question, "That the words proposed to be left out stand part of the paragraph," put, and negatived.—Question put, "That the proposed words be there added:"—The Committee divided:

Ayes, 2.	Noes, 7.
Colonel Dunne.	Mr. Baring.
Captain Jervis.	Mr. Beecroft.
	Lord Robert Cecil.
	Marquis of Hartington.
	Mr. Laird.
	Sir Morton Peto.
	Mr. Vivian.

Another Amendment proposed, to add the words, "It is obvious that the value of this comparison rests entirely upon the accuracy of the principle upon which the cost of the articles produced at Woolwich has been arrived at"—(Mr. *Baring*)—at the end of the paragraph.—Question, "That those words be there added," put, and agreed to.—Paragraph, as amended, agreed to.

Amendment proposed, after paragraph 16, to insert the following paragraph: "The evidence on this subject is conflicting"—(Captain *Jervis*).—Question, "That this paragraph be there inserted," put, and agreed to.

Amendment proposed, after paragraph 16*a*., to insert the following paragraph: "On the one hand, Colonel Boxer, Superintendent of the Royal Laboratory, and Mr. Whiffin, Assistant Accountant General of the War Office, state their belief that their comparison of the prices at Elswick and Woolwich is substantially correct. Mr. Rendel and Captain Noble, R.A., partners in the Elswick Company, object to any such comparison until the Royal Arsenal prices are ascertained on what they consider an accurate basis. Mr. Anderson, Assistant Superintendent of the Royal Gun Factory, who alone was responsible for the accounts, is of opinion that some saving would have been effected if all the guns had been manufactured at the Royal Arsenal, but he is unable to say exactly what is the whole cost of the Royal Gun Factory guns; and Mr. Baring, a Member of your Committee, and sometime Under Secretary of State for War, is of opinion that the comparison between the Elswick prices and the Woolwich rates is of no value for practical purposes."—Question, "That this paragraph be there inserted," put, and agreed to.

Paragraph 15 further considered—Amendment made.—Question, "That this paragraph, as amended, stand part of proposed Report," put, and agreed to.

Amendment proposed, after paragraph 16*b*., to insert the following paragraph: "Looking to the necessity for the application to the Elswick Company in the first instance, and to the fact that for two subsequent years both the Royal Gun Factory and the Elswick Works were employed to extremity, your Committee find themselves unprepared to impugn the wisdom of the course adopted by General Peel, and followed by succeeding administrations, with respect to the Elswick Company"—(Captain *Jervis*).—Question, "That this paragraph be there inserted":—The Committee divided:

Ayes, 5.	Noes, 4.
Mr. Baring.	Mr. Beecroft.
Colonel Dunne.	Lord Robert Cecil.
The Marquis of Hartington.	Mr. Laird.
Captain Jervis.	Mr. Vivian.
General Peel.	

Paragraphs 17, 18, 19, 20, 21, 22, 23, 24, 25, 26 and 27, negatived.

Paragraph 28, agreed to.

Paragraph 29, amended, and agreed to.

Paragraph 30.—Question put, "That this paragraph stand part of the proposed Report:"—The Committee divided:

Ayes, 4.	Noes, 6.
Mr. Beecroft.	Mr. Baring.
Lord Robert Cecil.	Colonel Dunne.
Mr. Laird.	The Marquis of Hartington.
Mr. Vivian.	Sir John Hay.
	Captain Jervis.
	General Peel.

Amendment proposed after paragraph 29, to insert the following paragraph:—"It appears to your Committee that the Armstrong field gun is the best known for field purposes. His Royal Highness the Field Marshal Commanding in Chief states that, in his opinion, Sir W. Armstrong's system surpasses in completeness any other, and his conviction is that England in this respect is ahead of any other country. Colonel Bingham, Adjutant General of Artillery, states, that he is perfectly satisfied with the Armstrong field gun; that it is the best gun known, and that this is the general opinion of officers of artillery of all classes"—

(Captain

Captain *Jervis*)—Question put, "That this paragraph be there inserted":—The Committee divided:

Ayes, 7.	Noes, 3.
Mr. Baring.	Lord Robert Cecil.
Mr. Beecroft.	Mr. Laird.
Colonel Dunne.	Mr. Vivian.
Marquis of Hartington.	
Sir John Hay.	
Captain Jervis.	
General Peel.	

Amendment proposed after the last paragraph, to insert the following paragraph: "At the same time, some of the military officers examined state that, in their opinion, we ought not entirely to rely for field artillery on breech-loading guns as being complicated, and liable to injuries from rough handling, and various accidents, and are inclined to retain a proportion of muzzle-loading guns for horse artillery"—(Colonel *Dunne*).—Question, "That this paragraph be there inserted"—put, and agreed to.

Paragraph 31—Amendments made.—Amendment proposed, to leave out from the word "says" to the word "particulars," in order to insert the words, "To bring our 1863 knowledge and experience and standard to test the guns of 1859 would, I think, not be fair. We do not think very much of those guns now. The guns of 1861 were very much better than the guns of 1859. The gun of 1862 is better than the gun of 1861. And with my present knowledge, I think the guns of last year are very bad in many particulars; but even taking the first gun, with its many defects (and I speak deliberately), I do not know of any breech-loading gun outside the War Department that is yet equal to it. Although it is the worst of all, still it is a very good gun. If I had known that those linings would have been spoken of, or if Sir William Armstrong had known it, we should not have lined them; we would have bored them out. They were to be made for 200 *l.* a-piece, and they have been made at 87 *l.*; and now, working that price up to 100 *l.*, I have made them as good as any guns that were ever made"—(Mr. *Baring*)—instead thereof.—Question, "That the words proposed to be left out stand part of the paragraph"—put, and negatived,—Words inserted.

Another Amendment proposed, to add the words: "On careful investigation, your Committee find that out of 570 12-pounders issued and in use, 13 only have been returned to the Royal Gun Factories for repair, three of which have proved unserviceable, and the remainder repairable at an inconsiderable expense"—(Captain *Jervis*), at the end of the last amendment.—Question, "That those words be there added"—put, and agreed to.—Paragraph, as amended, agreed to.

Paragraph 32, amended, and agreed to.

Paragraph 33—Amendment made, by inserting after the word "service" the words "as broadside guns."

Another Amendment proposed, to add the words, "They were originally required for use against wooden ships, and, whilst not sufficiently powerful for penetrating iron-plated ships, are as yet imperfect for general naval service, owing to the difficulty of managing and manufacturing the vent-piece. Nevertheless the 110-pounder is considered by naval men of eminence in their profession as a most valuable weapon in its present proportion to the armament of a ship, and the Duke of Somerset is of opinion that the navy has not got too many of them"—(Captain *Jervis*)—after the last Amendment.—Question, "That those words be there inserted"—put, and agreed to.—Further Amendment made.—Paragraph, as amended, agreed to.

Paragraph 34—Amendments made.—Paragraph, as amended, agreed to.

Paragraph 35, agreed to.

Paragraph 36, negatived.

Paragraphs 37 and 38, agreed to.

Paragraph 39, amended, and agreed to.

Paragraph 40.—Amendment made.—Question put, "That this paragraph, as amended, stand part of the proposed Report:"—The Committee divided:

Ayes, 6.	Noes, 2.
Mr. Baring.	Colonel Dunne.
Lord Robert Cecil.	Marquis of Hartington.
Mr. Dodson.	Captain Jervis.
Mr. Laird.	
General Peel.	
Sir Morton Peto.	

Amendment proposed, after paragraph 40, to insert the following paragraph:—"The time fuzes seem a most valuable discovery; but it appears that those hitherto made have become

uncertain when kept some time, and a new pattern has been adopted, which will supersede that used hitherto, which, it is hoped, will not be subject to the same defects"—(Colonel *Dunne*).—Question put, "That this paragraph be there inserted:"—The Committee divided:

Ayes, 2.	Noes, 7.
Colonel Dunne.	Mr. Baring.
Captain Jervis.	Lord Robert Cecil.
	Mr. Dodson.
	Marquis of Hartington.
	Mr. Laird.
	General Peel.
	Sir Morton Peto.

Amendment proposed, after paragraph 40, to insert the following paragraph:—"Sir William Armstrong, however, states that the concussion and time fuzes for land service are now perfectly satisfactory; and that with respect to the sea-service fuzes, the pillar fuze is the only one which has been matured, the time fuze now used being merely a temporary expedient until a more perfect fuze can be produced"—(Mr. *Baring*).—Question, "That this paragraph be there inserted," put, and agreed to.

Paragraphs 41 and 42, amended, and agreed to.

Paragraph 43—Amendments made.—Amendment proposed, to leave out the words "without prejudice or partiality"—(Captain *Jervis*).—Question put, "That those words stand part of the paragraph:"—The Committee divided:

Ayes, 4.	Noes, 5.
Lord Robert Cecil.	Mr. Baring.
Mr. Dodson.	Colonel Dunne.
Mr. Laird.	Marquis of Hartington.
Sir Morton Peto.	Captain Jervis.
	General Peel.

Another Amendment proposed, to leave out the words "Mr. Bashley Britten, Captain Blakeley, and Mr. W. Richards, and"—(General *Peel*).—Question put, "That those words stand part of the paragraph":—The Committee divided:

Ayes, 4.	Noes, 5.
Mr. Dodson.	Mr. Baring.
Colonel Dunne.	Lord Robert Cecil.
Mr. Laird.	Marquis of Hartington.
Sir Morton Peto.	Captain Jervis.
	General Peel.

Paragraph, as amended, agreed to.

Paragraph 44, amended, and agreed to.

Paragraph 45, negatived.

Amendment proposed, after paragraph 45 to add the following paragraph, "It appears to Your Committee that all the establishment and indirect charges, as well as those for material and labour, (which should be included in an account on commercial principles, for the purpose of showing the price of every article manufactured in the Royal Factories), should be definitively laid down, and a system of accounts founded on these principles should be adopted and insisted on in every manufacturing department. Without such an uniform system, no comparison of price can be made between articles supplied by contractors and those manufactured at the expense of the country"—Colonel *Dunne*.)—Question proposed, "That this paragraph be there added."—Amendment proposed to the proposed Amendment, by leaving out from the words "Your Committee that," to the end of the paragraph, in order to add the words, "a uniform system of accounts should be adopted for the manufacturing departments at Woolwich, by which the cost of guns and other produce may be clearly ascertained. The absence of such an account has much embarrassed Your Committee in comparing the cost of guns made in the Royal Gun Factories, and the price charged by the Elswick Ordnance Company"—(Mr. *Dodson*)—instead thereof.—Question, "That the words proposed to be left out stand part of the proposed Amendment:"—The Committee divided:

Ayes, 2.	Noes, 7.
Colonel Dunne.	Mr. Baring.
Captain Jervis.	Lord Robert Cecil.
	Mr. Dodson.
	Marquis of Hartington.
	Mr. Laird.
	General Peel.
	Sir Morton Peto.

Words

Words added—Question, That this paragraph, as amended, be added to the proposed Report, put, and agreed to.

Question, "That this Report, as amended, be the Report of the Committee to the House," put, and agreed to.

Adjourned to Thursday next, at Two o'clock.

Jovis, 23° *die Julii*, 1863.

MEMBERS PRESENT:

Mr. MONSELL in the Chair.

Mr. T. G. Baring.	Mr. Beecroft.
Sir Frederic Smith.	General Peel.
Colonel Dunne.	Mr. Laird.

The Committee deliberated.

Question, "That the Evidence taken before the Committee, with the Appendix, be Reported to the House,"—put, and agreed to.

Ordered, to Report.

EXPENSES OF WITNESSES.

NAME of WITNESS.	PROFESSION or CONDITION.	From whence Summoned.	Number of Days Absent from Home, under Orders of Committee.	Expenses of Journey to London and back.	Allowance during Absence from Home.	TOTAL Expenses Allowed to Witness.
				£. s. d.	£. s. d.	£. s. d.
Colonel Gardner -	Colonel - -	Shoeburyness - -	One -	1 1 –	1 1 –	2 2 –
Capt. R. S. Hewlett -	Royal Navy -	Portsmouth - -	One -	–	1 1 –	1 1 –
Capt. James Wainwright	Ditto - -	Spithead - - -	Three -	–	3 3 –	3 3 –
Capt. C. Ewart - -	Ditto - -	- - - - -	Four -	–	4 4 –	4 4 –
Rear Admiral Dacres -	Ditto - -	Bath - - - -	- -	–	–	2 6 –
Capt. Heath - - -	Ditto - -	Dorking - - -	One -	– 9 –	1 1 –	1 10 –
				TOTAL - - - £.		14 6 –

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Jovis, 12° *die Martii*, 1863.

MEMBERS PRESENT:

Mr. Beecroft.	Sir George C. Lewis.
Mr. Dodson.	Mr. Monsell.
Sir John Hay.	Major O'Reilly.
Captain Jervis.	Sir Morton Peto.
Mr. Laird.	General Peel.

THE RIGHT HON. WILLIAM MONSELL, IN THE CHAIR.

Colonel WILLIAM BETHEL GARDNER, R.A., called in; and Examined.

Col. *W. B. Gardner*, R.A.

12 March 1863.

1. *Chairman.*] WHAT official position do you occupy?—That of Chief Instructor at Shoeburyness.

2. What are the duties of that position?—To superintend the instruction generally in gunnery matters; the service of guns.

3. Does that position give you considerable opportunities of observing the practice of different descriptions of guns, and of forming an opinion upon them?—Yes; I think I have a very good opportunity.

4. I presume you have also attended the experiments, and have had considerable opportunities of seeing the preparations made beforehand for them, and the results afterwards?—I sometimes attend the experiments, but not officially; I am not officially connected with them, but I am often present at them; I know the preparations which are made beforehand, and I know the results after the experiments are over.

5. How long have you held your present position?—Since May 1859.

6. During that period, have there been many experiments tried with Armstrong guns?—Yes; very many.

7. I suppose with all sorts of calibres?—Yes, with guns of all calibres.

8. First, with regard to the heavy guns; what is the general impression that has been made upon your mind by what you have seen in your official position, and also by what you have witnessed in the way of experiments?—That is rather a large question to answer at once; but my general impression is this, that the gun is a very accurate gun; I may say remarkably accurate; that with considerable care it would be a useful gun; but that I have considerable doubts at present whether it is so formed as to stand the rough usage of service. Perhaps I might state, anticipating a question which will probably be asked, that the weak points of the gun in my opinion are the vent-piece and the breech-screw. The vent-piece is defective in strength, to begin with, and the breech-screw is liable to injury, from the fact of the face of the breech-screw being indented by the vent-piece breaking. If the surfaces of the vent-piece and of the breech-screw are not true, you have a concavity made on the screw, and you may go on breaking vent-pieces as often as you like. I had occasion to observe that the week before last, when we were at ordinary practice, two vent-pieces broke very quickly; the breech-screw was examined, and put into a lathe and rendered true; the next day, when we went to practice again, the vent-piece broke the second time; the breech-screw was examined, and found defective also on the face. From what I have observed, I should be inclined to think that that would always be a great defect in that description of gun.

9. You are speaking now from a considerably large induction, having had an opportunity of seeing those results produced in a very great number of cases?—Yes; I speak of what we observed the week before last, for instance.

10. Would you extend your recollection not only to the last week but to the system generally?—I cannot tell you precisely what number of vent-pieces have been broken since I have been acquainted with the experiments at Shoeburyness; there is a return, which of course the Committee can call for, but I think they would be found to be between 60 and 70 altogether.

11. Captain *Jervis.*] Do you mean since 1859?—Perhaps there have been more since 1859, because in the first instance the records were not, I believe, very accurately kept.

12. *Chairman.*] Can you tell since what period the records have been accurately kept?—I think within two years.

13. Mr. *Beecroft.*] Do you say then that within two years there have been 60 or 70 vent-pieces broken?—Yes, during the last two years there have been between 60 and 70 broken; I cannot tell the precise number.

14. *Chairman.*] Will you explain to the Committee,

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mittee, recollecting that the majority are not scientific men, what the precise effect is of the absence of close contact between the breech-screw and the vent-piece?—The effect would be either to admit the escape of gas, and so derange the bore of the gun, or else to injure the breech-screw, as I have just described; one of those two results would probably happen. In the gun to which I have just alluded, in which we broke two vent-pieces consecutively, the bouching, as it is called, at the end of the gun, protruded, and the gun itself is at this moment defective for that reason.

15. Mr. *Beecroft.*] You say that during the last two years between 60 and 70 vent-pieces broke?—Yes.

16. Can you tell me what proportion that would be to the number of rounds fired?—It might be any number, from the first round up to the hundredth; I cannot say which; it is very variable.

17. It is desirable to know the proportion, if possible?—It is; I believe you can get that by the return; but in the cases I have alluded to it happened after very few rounds indeed, perhaps two or three.

18. Captain *Jervis.*] The 60 or 70 vent-pieces you have mentioned were broken at Shoeburyness, were they not?—Yes.

19. In the Shoeburyness practice?—Yes.

20. *Chairman.*] Is there anything in the instructions with reference to the necessity of keeping the contact close between the breech-screw and the vent-piece?—There is. I will read to you an extract from our instructions. I read it in order to show how necessary it is that the surfaces of the vent-piece and the breech-screw should be true. It is this: "The allowance between the nose of the vent-piece and powder-chamber should be exactly $\frac{2}{1000}$ths of an inch, or $\frac{4}{1000}$ths difference in diameter. If less than this is allowed, any burr or upsetting of the vent-piece nose will cause it to jam in the gun, and if a greater allowance is given, the edges of the cup will be split open and blown by the gas into the space, and the faces will be destroyed. This enlargement of space may be found to occur from repeated firings, and is to be remedied by flattening out the nose of the vent-piece, which is effected by gently hammering it round the edge until the proper diameter is attained." Then, after a few paragraphs, it goes on to say: "From constant practice with the gun it may sometimes happen that a shoulder or burr is raised on the back of the vent-piece, which will cause the end of the breech-screw to act untruly on it, and break the vent-piece." That is where I think the failure will still arise, because nobody, or at least not one man in a hundred, when at all excited, would look, or, in fact, have the means of ascertaining that those dimensions are exactly true; then, if this burr occurs, or if these fittings, when you come to thousandth parts of an inch, are not observed, you will probably have the result which we had the week before last.

21. On service, I suppose, it would not be very easy to remedy those defects?—Not unless the men are very different from what they are now.

22. We are speaking now principally of heavy guns; with regard to the effect of the recoil upon the carriages, have you any remarks to make upon that subject?—I think, with regard to the guns as at present mounted on dwarf platforms, that the recoil is very severe and heavy, and it is a great question whether you must not revert to the old construction of platform, which Major Jervis knows as much about as I do. A modern alteration and improvement has been to do away with the pivot, to give greater facility of traversing; but I expect that, with the present arrangement, we shall have to revert to the pivot again to check the recoil.

23. Captain *Jervis.*] You are speaking now, I think, of the heavy guns; do your objections apply to the whole system, or are you alluding especially to any particular calibre?—I object to the whole system; but my answer had special reference to the 110-pounder. What I mean is, that the same results of breakage, which are the effects of using the breech-screw, will apply to the whole system; but not, perhaps, in the same degree in the smaller guns, of course.

24. *Chairman.*] These failures with regard to the breech-screws and vent-pieces took place during quiet practice, and would be very much more likely to take place if there was rapid firing?—Yes.

25. With regard to field guns, have you any special remarks to make which apply to them, and do not apply to the heavy guns?—Yes, I think, as a rule, that the field gun should be the simplest possible gun, and therefore, I would object to any superfluous screw or any detached part.

26. Sir *John Hay.*] In saying, the "simplest possible gun," you mean, I presume, always supposing it to be rifled?—I am not even prepared to say that.

27. You are not now speaking of any description of rifling, as against other descriptions, are you?—No, I am not prepared to say that the guns should all be rifled; the last report of our officers who visited the Continent was that the opinion in Prussia and in other countries where they had been in a great hurry to take up the rifled guns, was that about one-third should be rifled.

28. Is that your opinion also?—No, I am not prepared to say that; I should like to see a great proportion of smooth bores retained in the service. I would observe, that a good many of the great actions in America, that at Fredericksburg, for instance, took place at a short distance, and that the smooth bore came into play very well, as well as the rifled guns would have done.

29. Do I understand that it would be your opinion, that if there were a rifled gun which had not the weaknesses to which you allude, and which was equally strong and convenient with the smooth-bored gun, you would prefer even then to have a proportion of the field artillery of the smooth-bore construction, rather than to have a rifled gun which might be used both at long and short ranges?—Yes, what I should like to have would be a proportion, I am not prepared to say what proportion, of the smooth-bored guns retained.

30. General *Peel.*] Would not there be a disadvantage in having two descriptions of gun, the one smooth, and the other rifled, with regard to the ammunition?—Yes; but I think there is that disadvantage now.

31. Is it not all brought under one head now?—For myself, I think that we want a large shell with some guns and not with others; for instance, with a 12-pounder. I am not at all prepared to say that the ammunition for one field gun is all that is required.

32. The disadvantage of which you speak, however, would be increased by having a part of the guns smooth-bored and another part of them rifled, would it not?—Yes, exactly so.

33. Sir

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33. Sir *John Hay.*] Is your opinion of the weakness of Armstrong guns solely confined to the vent-piece and the breech-screw?—No, I think not; taking the gun as it stands in its best form, supposing the breech-screw is strong and the vent-piece strong also, I think that a handful of dust thrown over the breech-screw at any time would clog it so much as to render it very uncertain in screwing up.

34. Supposing the Armstrong system to be applied to muzzle loaders, the disadvantages to which you allude do not occur, do they?—So far as regards that, they disappear; if you allude to the construction of the gun, I should remark that that remains to be proved; I am not clear upon it; my own impression is, that the gun ought to be solid as far as possible; I have a very strong feeling, although, of course, I do not know whether others share it, that the more joints you have in a gun, and the more parts you have which are liable to be detached, the less the gun will be able to stand the hard work of service. We know that after the Crimean war there were plenty of guns, Russian guns and others, to be seen, which had been knocked about considerably, and which bore the marks of shot all over them; those guns remained in position up to the last, so the officers who saw them assured me; there was no intention of removing them, simply on the ground of the blows which they received on the muzzle. I very much doubt whether the guns at present constructed could stand those blows.

35. Mr. *Beecroft.*] Do you not know that the Russian guns are made of a superior quality of iron?—I do not know that positively; I have heard it so stated.

35*. Captain *Jervis.*] Assuming that it is desirable to introduce a good rifled gun into the service, in your experience at Shoeburyness, have you seen any gun which, in your opinion, is better fitted for the purpose than the Armstrong, both as being more simple and more accurate?—I do not think that any gun I have seen is as accurate; with regard to anything else, I cannot say, for this reason, that I have nothing to do with the experiments; I simply know of them as any ordinary spectator does; perhaps I have a little more means of getting information, but I cannot pronounce an official opinion.

36. Do you know, with regard to the general opinion of the artillery officers at Shoeburyness, whether any gun has been tried which appears to them preferable to the Armstrong, as a gun to be introduced into the service?—I think no gun has been tried on equal terms with the Armstrong at present, therefore it is impossible to arrive at any opinion on the gun; it is necessary to go into it at great length; there are many considerations, of course, besides the gun itself.

37. *Chairman.*] Have you seen any rapid firing with the Armstrong guns?—Only with the 12-pounders.

38. Have you seen them tried with the old guns, the rifled guns against the smooth-bore guns?—I have not seen them tried against the smooth-bore guns on the same day; but the object I had in view was this: to allow the officers under instruction to form a comparison in their minds, and we fired two 12-pounder Armstrongs against the targets, some in line, and some in column, at distances of 800 yards off, or thereabouts, very rapidly; and we fired under similar circumstances, the day afterwards, a 9-pounder gun and a 24-pound howitzer, changing round and shifting, &c. wheels; and the general impression on my mind was that the smooth-bore gun, under those particular circumstances, was as good as the Armstrong; in fact, if I remember rightly, rather better.

39. You mean to say that the practice was better?—Yes; that is to say, taking the ordinary firing at a large target and short distance; under those circumstances, the smooth-bore gun would do as well as the other; but on coming to long distances and small targets, that would have been reversed.

40. Even at 800 yards, with quiet firing, do you not think that the Armstrong could beat the smooth-bore altogether?—Most decidedly.

41. Was it on account of bad firing, then, that they did not do so in this instance?—It was simply that the men were hurried and disturbed on that occasion; they did not know what order was to follow; just as they were about to fire they were ordered to limber up, and then they had to shift wheels, and things of that sort.

42. Does not one of the officers who reported upon the Armstrong guns used in China make some remarks upon the men not using their sights; you will find them, I think, in the letter of Major Hay?—Major Hay says this: "The sights I consider very good; but, as a general rule, I observed that the Numbers 1 paid very little attention to the vernier on the scales, and resorted chiefly to guess-work for adjusting their elevation and deflection; this is not to be wondered at under fire, when even at drill they experience difficulty in working out the corrections." I think Major Hay was perfectly right. I doubt very much whether verniers will be ever used.

43-4. Sir *John Hay.*] I think you state that you consider smooth-bored field artillery to be more serviceable up to 800 yards range than the rifled artillery; not speaking of any special rifled artillery, but of rifled artillery in general for field purposes?—Not specifically up to 800 yards; I said for short ranges.

45. Do you take into consideration that the small arms now used by troops are rifled small arms, and that they probably would have, at a longer range, a greater effect upon smooth-bored artillery than was formerly the case when troops were armed with smooth-bored arms?—I doubt about any action being decided at long ranges; that is my opinion. I think there is strong evidence given on that point by Colonel Woolsley, if I remember rightly, who wrote the account of the China campaign; I think he has some observations upon that very head which are very interesting indeed; he speaks of a regiment of the line firing at 600 or 700 yards and not hitting a single Tartar, or something of that kind, and he goes on to say how useless these long ranges would be, and that the training of the infantry was defective in that point; that they should not be taught to rely upon long ranges.

46. Therefore, practically, a smooth-bore gun might be silenced by small arms?—I think it is a question of ground; if the ground were favourable it might be.

47. Would not there be a greater chance of a smooth-bore gun being silenced by small arms than of a rifled gun being silenced by small arms?—I should be very doubtful indeed about that; I think it is a question of ground very much.

48. *Chairman.*] Do you recollect how many separate parts there are in an Armstrong gun?—I can

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I can tell you what is called the gun complete, the 110-pounder gun has 12 parts.

49. Which of those parts do you object to and find fault with?—I object to all the parts, such as the breech-screw and the vent-piece, which require lubrication. I think that is the first objection; and then the second is to the parts in detail of each, for instance, the faces of each, which require careful adjustment.

50. Generally I gather from your evidence that you would prefer a simpler gun for the purpose of the field guns for service?—Yes.

51. With regard to guns of position, do you consider that the Armstrong are fitted for that purpose?—I would rather have a rifled gun for a gun of position, but I think not a breech-loader.

52. What is your objection to breech-loaders?—I have mentioned one objection, which I thought a very strong one. When we were firing at the work which we made at Shoeburyness last year (in fact, the same thing occurred the week before last), behind the embrasures there were some old obsolete guns, unserviceable guns, which we were firing at; when the shots struck the parapet they threw dust and dirt upon those guns, and my impression is, that no amount of lubrication would have enabled you to fire those guns immediately; they would have required cleaning again.

53. Did you try it?—No, we could not try it.

54. Sir *John Hay.*] If the breech-loading rifled gun can be made as enduring and serviceable as the muzzle-loading rifled gun, would you not prefer the breach-loading gun to the muzzle-loading gun?—I think I should for special purposes. I think behind an iron shield, where the embrasure is small, it would be desirable to have the breech-loading rifled gun. I may say also for casemates generally.

55. And for naval purposes?—I do not know much about the Navy.

56. Is not a broadside gun on a ship's deck very similar to a gun in a casemate?—Yes.

57. *Chairman.*] Were you present at the experiments which were tried both in November last, and again very recently, with the Armstrong gun and the Whitworth gun against the iron target?—Yes, I was.

58. What was the impression produced upon your mind with regard to the power of penetration of the Armstrong; which of the two guns were the more successful on those two occasions?—I think as regards the Warrior target that the Whitworth was decidedly the more successful. I know that the Whitworth shell got through and the other did not; that was at 800 yards; but in the firing the other day at the solid target (Major Inglis's), I do not think that any gun made a great impression upon it.

59. At what distance was that?—200 yards on the last occasion.

60. Sir *John Hay.*] Was that due to the gun or to the projectile?—I think to both; I think the projectile is a very remarkable one; I think in all our arrangements now it is as necessary to take care of the projectile as it is of the gun.

61. Captain *Jervis.*] Do you remember the charges that were used the other day. I saw an account in the newspaper, according to which on the last occasion the rifled Whitworth gun was fired with 25 pounds of powder, the service charge being 14 pounds, and the Armstrong was fired with 25 pounds of powder instead of 33, which was the service charge?—Yes, that was so, I believe.

62. Therefore we can derive no valuable information from such an experiment as that, in which one gun was fired with about double the charge which it ought to have had, and the other with about half what it ought to have had?—Exactly.

63. *Chairman.*] Have you observed anything with regard to the stripping of the projectiles of lead or zinc, or whatever the covering of them may be?—No, I think I have seen a case of stripping, but very seldom.

64. General *Peel.*] The Whitworth gun, which you alluded to just now, was made upon the Armstrong principle, was it not?—Yes, I think it was.

65. It was an Armstrong gun with Whitworth rifling?—Yes.

66. *Chairman.*] It was stated before this Committee last year that the duration of the Armstrong gun is 10 times as great as that of the ordinary 68-pounder; is that your opinion?—No, not at all; it is a question what the duration of the gun is; how many vent-pieces, for instance, a gun is supposed to stand, or how often it requires to go under repair; but I am not aware that the experiment has ever been tried.

67. It was stated also that there were guns which had been fired between 2,000 and 3,000 rounds a piece, which are still uninjured; have there been any guns that have been fired with rapid firing continuously for any such number of times as that?—I am not aware of it.

68. Sir *John Hay.*] Would not a wrought-iron gun have a longer duration than a cast-iron gun?—I think it would.

69. Considerably?—I am not prepared to go into the whole question; no doubt some nations have very superior cast-iron.

70. Does not cast-iron crystallize under concussion more rapidly than wrought-iron, and, therefore, is less durable; is not that the case?—Yes; at present the cast-iron guns are not equal to the wrought-iron guns as now made.

71. *Chairman.*] Did not the French fire a gun 2,000 or 3,000 rounds rapidly to test it?—The trial of the Krupp's gun, a 12-pounder, was this (we have the whole account at Woolwich in the Proceedings of the Institution, and the Committee can have them if they desire): they fired 3,000 rounds from each of the two Krupp's guns, 50 in the morning and 50 in the evening; that is 100 a day; then they went on to fire the guns with extra charges, and finally they fired at one of the guns, and because it would not stand being fired at better than the old ones, they would not have the Krupp's gun.

72. It was stated last year to us by General Tulloh, that the defects in the vent-pieces of Armstrong guns were now remedied. I gather from your evidence that the experience you have had does not lead you to that conclusion?—I only speak of what has happened lately at Shoeburyness; we have in the last fortnight destroyed the vent-pieces of five 110-pounders in the ordinary practice, and those vent-pieces had the improvement on the back.

73. Sir *John Hay.*] I should like to ask you, as a general *resumé* of all you have just stated, whether, if you were called upon to decide what guns should be adopted for the service, from the great experience you have had, you could name any special gun at this moment which is the best adapted for the general purposes of war?—My experience does not lead me into the general question; I have nothing to do with experimental guns;

guns; when the guns come into the service, then we frame a drill for them, and work them.

74. I wish you to answer the question, if possible, for the information of this Committee; we are anxious to ascertain what gun is best for the service, and whether the course that has been hitherto adopted has been a wise one. The question I ask is not with reference to your official position, but with reference to the opinion which probably, as an artillery officer, you have formed, and which would be of value to the Committee, with reference to those guns which are used in the service, and to those which are now being experimented on, which is the more desirable to adopt for purposes of war?—That is an exceeding difficult question to answer; of course I cannot separate my official position from my private judgment; I could not give a private answer; I should be glad to see the whole subject opened, as indeed is being done; at present I think we are in a very unsatisfactory state.

75. Mr. *Beecroft.*] Did I rightly understand you to say, that no gun has been tried on equal terms with the Armstrong gun?—No gun has gone through the amount of experience and trial that the Armstrong gun has, that I know of.

76. Therefore, under those circumstances, would it not be impossible for you to draw a comparison between it and any other?—I would not commit myself by giving an opinion on the subject; I shall be very glad when the thing has been gone into.

77. Captain *Jervis.*] Do you remember that when the Armstrong gun was introduced into the service, there was a careful inquiry and a considerable amount of experiment as to whether it was the best gun that could be introduced at that time, and the Committee decided that it was the best gun to be introduced?—We all had our opinions as to that; my own opinion at that time was that the thing was done very hurriedly; I regretted it very much indeed.

78. Was that because of the insufficiency of the evidence, or because you thought the Committee came to a wrong decision?—I thought that the Committee were hurried.

79. And that they came to a wrong decision?—Yes.

80. In what particular did you think the decision wrong?—I think they took a complicated instead of a simple gun.

81. Sir *John Hay.*] What simpler gun would you have preferred to the gun which you object to?—I have my own ideas upon the subject; but unless the Committee wish it I would rather not give them.

82. I think the Committee would be very glad to hear them; they are of very great value?—It is a matter of opinion entirely.

83. It is as a matter of opinion that we ask you?—The subject now is being investigated very fully, and I should be sorry to give you an opinion which might prejudice others in any way whatever; I think probably a very few months will settle whether Sir William Armstrong or his competitor is in the right; but as a rule I like to have an iron shot and muzzle-loader for general purposes; that is an important thing.

84. Captain *Jervis.*] Has that gun yet been brought out, a muzzle-gun with an iron shot, with perfect practice at long ranges?—There are two or three gentlemen who think they have succeeded very well, Mr. Lancaster, Mr. Whitworth, Captain Scott, and Mr. Blakeley; the French too consider that they have succeeded perfectly.

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Major Hay says in his evidence, "On several occasions our Armstrong batteries were firing alongside the French rifled guns. I observed that our rapidity of fire was much greater; their guns and carriages combined, although having the same sized projectile, are much lighter than ours, eight small ponies having taken them everywhere. The accuracy of the French gun, though not equal to ours, was quite sufficient for all ordinary purposes." Of course the question is what is meant by "ordinary purposes;" Major Hay has left that undefined.

85. General *Peel.*] I understood you to say that the Committee were appointed to confine their attention to one complicated gun; were not their orders to inquire into every gun then known?—I think I said that they adopted a gun which in my opinion was complicated.

86. They tried every gun, did they not?—I believe they did.

87. And the Armstrong was the best gun according to their conclusion; they had no orders to try merely the Armstrong gun, but they tried every gun that could be submitted to them, did they not?—Yes, I think they did; I only gave my opinion.

88. You were not a member of the Committee, I believe?—No, I was not.

89. Sir *John Hay.*] Is not the endurance of a rifled gun more likely to be severely tested by the friction of hard metal over hard metal, than where a soft metal is interposed between them?—I think so.

90. Is it not desirable then for the endurance of rifled guns, that the iron projectile which you have suggested should be protected by the interposition of some softer substance, to do away with the amount of friction which can only be saved by that interposition?—Yes; the French have succeeded in doing it, by placing a soft substance on their buttons. I am told that in the other hard shot guns, the Lancaster and Whitworth guns, the wear is not extraordinary.

91. Has no inventor in this country interposed a soft substance on the muzzle-loading projectile, which abates the friction which you say may occur?—Sir William Armstrong has with his shunt gun.

92. Have you had much experience with that description of gun?—I have seen it fired; I have not had much experience; it is still an experimental gun.

93. Have you formed any opinion of the advantage or disadvantage of it?—I prefer it much to the breech-loader.

94. Do you prefer it to the other descriptions of gun?—That requires experience, but I prefer it to the breech-loader.

95. Is it a simpler description of gun?—Yes.

96. It obviates the disadvantages of the old Armstrong system as to the vent-piece and the breech-screw, does it not?—Yes.

97. And may it not be favourably compared with other muzzle-loading guns as a serviceable gun?—I think it might.

98. And has it not the advantage, if it be an advantage, of interposing a soft substance to remove the possible friction which might occur by an iron projectile rubbing over another iron substance?—Yes.

99. With reference to the Whitworth projectile which was driven through the iron plate, was not that projectile supposed to be made of a very hardened description of steel, a description of steel so hardened that it would be likely to be

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harder than the interior tube of any gun?—It must have been very good metal indeed to stand as it did, but I can say nothing of it relatively.

100. Major *O'Reilly.*] Am I right in understanding that your chief and essential objection to the class of guns of which we have been speaking is to the principle of breech-loading?—Yes.

101. And that that objection, as you have stated it, may be said to be two-fold, arising from the injury to the vents in breech-loading and from dirt?—Yes.

102. A distinguished French artillery officer suggested to me a third disadvantage upon which I wish to ask your opinion; it was this, that in the case of service in the field, campaigning, if the artillery were constantly hard worked for a series of days, suppose it were in covering a retreat, and the men were exhausted daily by work, they might neglect to clean up their guns properly in the evening, and the consequence would be that the next day the vents would be filled with hardened dirt or with rust, and the gun would be so rendered unserviceable; do you think that is a practical objection?—I think it is a very strong objection indeed; it has been already mentioned by one of our officers, who in reporting from China states a similar fact; he says, "On the morning of the 22d August, on returning to Sinho, after having bivouacked at Tangku in the rain, the breech-screws were nearly completely jammed with rust, and if we had had to renew hostilities at daylight that morning, the gunners, who were already over fatigued, would have been severely taxed in getting the guns in working order." When I read that I felt confident in my own mind that we had got the wrong gun, because this Colonel Barry is a very good officer, and I am perfectly sure that all proper means were taken by him to have his battery in good order; and therefore, I think that if he made such a report as that with regard to what occurred on the morning of the 22d August the system must have been a very defective one indeed.

103. Are you not aware that in the campaign in China there was not anything like the amount of severe labour on the men that I have spoken of which might occur in a campaign in which the forces were in the minority, or were acting on the defensive for a series of days in retreating?—No, I believe not; but there are many officers who have been in China who could speak in detail upon that subject.

104. Sir *Morton Peto.*] Can you tell the Committee whether in the recent case of the five guns at Shoeburyness, in which the vent pieces were destroyed, there was anything exceptional; was the trial they underwent severe?—No, it was ordinary practice; very quiet practice.

105. I gather generally from your evidence, that your chief objection to the Armstrong gun is its complication?—Yes.

106. What you desire is greater simplicity?—Yes.

107. And a gun which in actions and severe service is less liable to get out of order?—Yes.

108. *Captain Jervis.*] While stating those objections, you say that you do not know of any other gun at the present moment that is to your mind more simple and less liable to get out of order?—I do not know about that.

109. Will you tell the Committee what it is, if you do know of one?—I am hardly prepared to answer that question at present.

110. Mr. *Beecroft.*] You prefer a simple gun for all practical purposes?—I mentioned a case in which it is possible that breech-loaders might be used with advantage, namely, the case of casemates or in cupolas.

111. Or on board ship?—I should have fancied it might be used on board ship, but I do not like to say much about the naval service. I should like to add, if the Committee will permit me, that one reason why I object to a breech-loader is that you require with it a fuse of a particular construction; the fuse cannot be lighted by the flash of powder, and you require a lighting apparatus in the body of the fuse; that in itself necessitates a complicated arrangement. Again, the setting of this fuse is not an easy matter, for Major Hay says, in his report under the head of time fuses, "Those fuses were found to be so uncertain that they were seldom used throughout the operations; and although they were those that had been last received, they either burst in the muzzle or very short. I found that in action under fire it is very difficult to get the men to fix them carefully." Of course, the same objection as regards fixing would apply in these days.

112. *Chairman.*] Generally speaking, I gather from your evidence that you would not in the case of active service wish to rely upon the Armstrong gun as at present constructed?—No, I would not.

113. Sir *John Hay.*] You mean, do you not, the Armstrong breech-loading gun?—Yes, the Armstrong breech-loading gun.

114. Or any other breech-loader, I suppose?—I do not like breech-loaders of any kind that I have seen yet; I have not seen one that I like.

115. Have you seen the patent proposed by Mr. Westley Richards. I allude to the large gun, not the small arm?—No.

116. You have not had any experience of that gun?—No.

Jovis, 19° *die Martii*, 1863.

MEMBERS PRESENT:

Mr. Baring.
Mr. Beecroft.
Mr. Dodson.
Colonel Dunne.
Sir John Hay.
Captain Jervis.
Mr. Laird.
Sir George Lewis.
Mr. Monsell.
Major O'Reilly.
General Peel.

THE RIGHT HON. WILLIAM MONSELL, IN THE CHAIR.

Captain SIR WILLIAM WISEMAN, Bart., R.N.; Examined.

Capt. Sir *W. Wiseman*, Bart., R.N.

19 March 1863.

117. *Chairman.*] WHAT official position do you occupy?—I am Vice President of the Ordnance Select Committee.

118. You were a member of the Committee appointed by the Secretary of State for War to report upon the best description of rifled cannon to be adopted for field service?—I was.

119. Will you be so good as to put in a copy of the instructions that were given to that Committee by the Secretary of State for War?—I will.

120. Do you recollect the date at which that Committee was appointed?—The Committee met for the first time on the 11th of September; I think it was appointed towards the end of August.

121. It reported on the 16th November?—It reported on the 16th November, and was broken up on the 12th January 1859.

122. What steps were taken by the Committee to obtain complete information upon the subject referred to them?—When first the Committee met we carefully considered the tabulated results of the various experiments that had been carried on with rifled guns, and it was quite clear to us from those experiments that there were only two systems of rifling with respect to which it was advisable to go into lengthy or expensive experiments, which were Mr. Armstrong's and Mr. Whitworth's. We separated those two systems from the rest, on account of their evident superiority to any of the others, but we also proposed to carry on experiments with Mr. Lancaster's, with Mr. Lynall Thomas's, with Mr. Jeffery's, and Mr. Warendorff's. Letters were directed to be written to Mr. Armstrong, Mr. Whitworth, and Mr. Lancaster, requesting them to favour the Committee with their views on the subject of rifled guns generally.

123. What replies did you receive from them?—The replies are very long ones; they are in the correspondence in the letter book of the Rifled Cannon Committee.

124. Will you be so good as to put them in?—I will.

125. What experiments were made or witnessed by your Committee before you came to any conclusion?—We held 66 meetings; and I think at every meeting there were experiments carried on. I should say at least 60 different days were occupied in experiments.

126. And those experiments were chiefly carried on between those two guns, the "Whitworth" and the "Armstrong"?—Almost entirely between the "Whitworth" and the "Armstrong."

127. Did you visit any of the manufactories for the purpose of seeing how the manufacture was carried on?—When we first met we thought that it would be necessary to visit both Sir William Armstrong's and Mr. Whitworth's manufactories, in order to ascertain their method of manufacturing guns; but we only visited Mr. Armstrong's because we had no proposal from Mr. Whitworth before us for constructing guns at all. The gun which we fired rifled on his principle was a 9-pounder gun-metal block, bored to take a 12-pound projectile.

128. Colonel *Dunne.*] Was there any peculiar construction in the boring out of that gun of Mr. Whitworth?—It was bored out as the guns are now bored out.

129. On the hexagonal principle?—Yes. Not perhaps exactly as they are now.

130. *Chairman.*] Was Mr. Whitworth at that time carrying on any manufactory of guns?—We had no information whatever upon that subject, except that Mr. Whitworth said he was carrying on experiments with homogenous iron; but he did not propose any gun of that metal to us.

131. What other steps did you take in order to enable you to make a selection of the best gun?—We travelled the ammunition connected with the gun, packed in the usual way in limbers, 500 miles. We tested the projectiles for penetration into earth and into timber; we frequently tried the effect of the projectile as segment shells upon the targets. The rest of our experiments were directed towards ascertaining the accuracy and range of the gun, and its general fitness for use as a field gun, and from the result of those experiments we came to the conclusion (in fact, we had no other gun before us save the brass guns rifled on the hexagonal principle) that Mr. Armstrong's gun was very superior to any other, and recommended its adoption for field service.

132. In point of fact, Mr. Whitworth's gun was not very much brought under the notice of that Committee?—No, the only gun we tried at all, saving the large cast-iron 32-pounder, was the gun I have described.

133. General *Peel.*] You say that you had no other gun before you, but were there not several other guns mentioned by you just now?—Yes, we separated those two guns from the others because they were so manifestly superior.

134. That was the act of the Committee?—

Capt. Sir *W. Wiseman.* Bart., R.N.

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That was the act of the Committee. Those were the only two field guns brought before us.

135. But in consequence of their superiority, you did not try any other?—Yes.

136. *Chairman.*] Do I gather correctly from you, that it was through Mr. Whitworth's own act that his gun did not receive a larger amount of your consideration than it did?—Certainly, inasmuch as we found a great difficulty in obtaining ammunition of any sort; I never saw, myself, from that gun, a shell with a fuse, or a bursting charge of powder fired; there were no shrapnel shells for it. We tried solid shot, and the same description of shot lengthened with a hollow in it, for containing the powder, but we never had a fuse for it.

137. But if you had gone to Mr. Whitworth's factory would you not probably have been able to try the gun in a better way, and seen more of those things?—We could not have tried the gun at all at his factory. Mr. Whitworth, in a letter to us, informed us that he did not propose any particular fuse, or any particular description of shrapnel shell.

138. That would appear, I presume, in the letters which you will put in?—Yes.

139. Mr. *Beecroft.*] In that case you had no means of ascertaining the relative merits of Mr. Whitworth's and Mr. Armstrong's guns?—With regard to the range and accuracy with shot and shell, we had every opportunity of judging; we fired a great many rounds with Mr. Whitworth's gun, and you will find the results are exactly laid down in the Report of the Committee, with diagrams. But we could not test his shell as a live shell, because there was no fuse for it, and we could not test it as a shrapnel shell, because he never proposed one.

140. His shells were not tried?—Not with bursting charges.

141. *Chairman.*] They have been very materially altered since that time, have they not?—Yes. I thought the Committee might like to see the alterations that have been made, and I have had a drawing made to show the Whitworth projectile as it was when we tried it, and as it is now. (*Handing in a Drawing.*)

142. Captain *Jervis.*] I want to know whether there is any *précis* or abstract of the various experiments which that gun underwent?—I think there is at the War Office.

143. Has the Ordnance Select Committee got none?—I think they are all at the War Office, but I am not quite positive.

144. Can you say as to whether the proposal on the part of Mr. Whitworth with respect to this gun was a new idea on his part, or whether it was a subject which he had been studying some time, and which he was maturely prepared to bring forward?—I think he first sent in a gun rifled on the hexagonal principle in 1856, at the time our Committee was dissolved by General Peel; the rifling of his gun, I have no doubt, had arrived at maturity; but with regard to projectiles, fusees, and other necessary adjuncts to his gun, they were then in a very crude state indeed.

145. Did your Committee request leave of Mr. Whitworth to go down and examine his works to see how his guns were being manufactured?—No; Mr. Whitworth was informed by the War Office that we were going there, and I think we had no other communication with him.

146. Did you receive any request from Mr. Whitworth to do so?—I think not.

147. Have you seen a letter of Mr. Whitworth's published in the "Times," in November last, where he dwelt very strongly on the difficulty which he had in getting the Select Committee to go down to his works?—I have read that letter; I am quite sure that Mr. Whitworth never wrote to the Rifled Ordnance Committee urging them to go down there. I have looked carefully through the letter book, but I cannot find anything about it.

148. Are you aware, as a Member of that Committee which sat in 1858, whether a programme was previously submitted to Sir William Armstrong, which was not submitted to Mr. Whitworth?—No, there was no programme sent to any body; the same letter was written to all three, to Mr. Whitworth, Sir William Armstrong, and Mr. Lancaster; we wrote to the latter gentleman because he had rifled guns in the service.

149. Is it also correctly stated by Mr. Whitworth, that he was not allowed to be present at the trial of his own gun?—No; I can show from the letter book that we have written to Mr. Whitworth, naming the hours during which the tides would answer for practice for several days, and requesting him to name the time that would be most convenient for him to attend.

150. Will you put in a copy of those letters?—I will.

151. *Chairman.*] You have been asked a question with regard to the investigation that was carried on before the Ordnance Select Committee. The last Report that was made on the subject before the appointment of your Committee, was in February 1858, was it not?—I do not remember the date.

152. Will you just read the letter dated the 12th of October 1857, from Mr. W. Cator, at page 164 of the Appendix to the Report from this Committee last year?—"8, Great George Street, Westminster, 12th October 1857. With reference to letter dated War Office, Pall Mall, 14th October 1857, the Committee beg leave to forward the enclosed reports of practice with Mr. Armstrong's breech-loading gun, and a 32-pounder (56 cwt.) service gun. The Committee defer making any report relative to Mr. Armstrong's gun until further experiments have been carried out, the programme for which is now under consideration."

153. That was, I think, the last report made by the Select Committee, before the appointment of your Committee?—I do not know.

154. Captain *Jervis.*] Is it the fact that Mr. Whitworth was not allowed to have his own trainer to work his gun, while Sir William Armstrong was allowed to have his own trainer?—I attended every experiment, and I can say that neither Mr. Whitworth nor Sir William Armstrong's people ever went near the gun; an artificer was there of Sir William Armstrong's to reface the copper in the breech and vent-piece, when necessary, because our artificers knew nothing about it at that time.

155. Mr. *Laird.*] Had Mr. Whitworth the same facilities as Sir William Armstrong?—We should have made no objection to his having an artificer present.

156. But he had not them?—He had not, because there was no necessity for it.

157. *Chairman.*] In the course of the experiments

ments which you carried on with Sir William Armstrong's guns, did any of those inconveniences which have since arisen appear, such as the giving of the vent pieces?—Not one.

158. General *Peel.*] How many guns did you experiment with?—Principally with an 18-pounder, and when we made our report, 1,500 rounds had been fired from this gun; we also tried a 12-pounder, and ultimately a 32-pounder.

159. The question of field guns was the only question that was referred to you?—We only reported on field guns.

160. But you were a member afterwards of another Committee, which recommended the introduction of larger sized guns?—Yes; a Committee was formed by direction of the Secretary of State at the wish of the Admiralty, to decide upon the best calibre of guns for naval purposes, and we recommended, I think, as nearly as possible, the calibres which are at present in the service.

161. Colonel *Dunne.*] Was that calibre confined to the naval service, or did it apply to all the service?—It was intended for all services.

162. *Chairman.*] For guns of position as well as naval guns?—Yes, fortresses and ships.

163. When was that Committee appointed?—I do not remember the date.

164. General *Peel.*] What year was it?—I think it was the end of 1859 or beginning of 1860.

165. *Chairman.*] Were the members Colonel St. George, Sir William Armstrong, Captain Noble, and yourself; did they form the Committee?—Yes; they formed the Committee.

166. That was the Committee which approved of the adoption for the naval service of Sir William Armstrong's 40-pounder 32 cwt. gun?—Yes.

167. That Committee also recommended that the 6-pounders, 12-pounders, 100-pounders, and 290-pounders, should be guns of Sir William Armstrong's construction?—Yes.

168. By that, I presume the Committee meant the guns should be introduced into the service?—Yes; the Committee meant that they should be introduced into the service after a sufficient number had been tried if they turned out well.

169. Then by whom was it decided finally that any of those guns that have been introduced into the service should be introduced?—I think several of the larger guns were introduced by directions of the Secretary of State, without waiting for the final report of the Ordnance Select Committee, but ultimately we reported in favour of them up to 110-pounders.

170. What were the naval guns?—The naval guns were simply service guns shortened; they were adopted by direction of the Secretary of State, in consequence of the Admiralty desiring to have such guns; they wished to have them on the recommendation of Captain Hewlett.

171. And the whole of the guns referred to were breech-loading guns?—Yes.

172. General *Peel.*] The Secretary of State for War never supplies any guns to the navy without a requisition on the part of the Admiralty, does he?—No; never.

173. *Chairman.*] Captain Noble, who was one of the Committee recommending the introduction of those guns, has since become a director of the Elswick Company, has he not?—He has become a partner there.

174. I presume that, in your position as Vice-Chairman of the Ordnance Select Committee, you have been present at most of the experiments that have been tried since the period we were speaking of?—At nearly all of them.

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175. Now, with your experience of the last two or three years with regard to this subject, what is your present opinion with respect to the Armstrong breech-loading gun?—I think, as far as range and accuracy go, we have had no system of rifling yet that has excelled it, and very few that come at all near to it. It has one disadvantage in the heavy natures of guns, which is that the vent-pieces are liable to break, but I know of no occasion where this has occurred where men have been injured by it. At first the vent-pieces used to be blown out from neglect in not screwing the breech-screw up tight. That has been remedied by the new form of vent-piece which has a projection at the back, into which the end of the breech-screw fits. It is almost impossible now, unless the screw is not touched at all, to blow the vent-piece out.

176. But it is the fact that the vent-pieces still continue either to be blown out or broken, and the gun rendered unserviceable?—They continue to be broken in the larger nature of guns, but I do not think they are blown out.

177. Colonel *Dunne.*] In the smaller guns it is not so, is it?—I think myself that the small gun is nearly perfect now.

178. Up to what range?—Certainly up to the 40-pounders.

179. Did you read the evidence given by Colonel Gardner of his experience at Shoeburyness?—I did not.

180. I think he said that 60 or 70 vent-pieces had gone during the last two or three years?—I have no doubt they were chiefly the old pattern, and made of steel.

181. Have you been present at many experiments when there was rapid firing with those guns?—Yes.

182. How many rounds?—100 rounds; from 40-pounders, 20-pounders, 100-pounders and 12-pounders.

183. Never more than 100 rounds?—Not at one time.

184. Is it not the fact that the Admiralty have discontinued their requests for those breech-loading guns?—Yes; but simply because they have as many as they require at present.

185. Not from any feeling of distrust on their part with respect to the efficiency of the guns?—I think not; I think the navy generally approve of them; but you would obtain much better information from Captain Hewlett, who commands Her Majesty's ship "Excellent," on that subject.

186. Colonel *Dunne.*] Are you aware whether the guns, whose vent-pieces were broken, were loaded with the ordinary service charge, or with an experimental charge?—In the case of the 10 vent-pieces broken at Shoeburyness, with the 100-pounders, four out of the 10 were broken with very exceptional charges, and the other six with the ordinary service charge.

187. *Chairman.*] Are the Armstrong guns generally fired with a full charge?—Yes; there is only one charge; that is to say, one for shot, and one for shell.

188. Mr. *Laird.*] As to this recommendation of the special Committee with regard to the Armstrong gun, Sir William Armstrong and Captain Noble were on that Committee?—Yes.

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189. At that time Sir William Armstrong was the engineer for rifled ordnance?—Yes.

190. He was appointed in February 1859?—Yes.

191. Sir *John Hay.*] Which is, in your opinion, the more enduring gun of the two (taking a gun of the same size, with the same charge)—a gun rifled on the hexagonal principle of Mr. Whitworth, or a gun of Sir William Armstrong's pattern, rifled, with a lead-coated wrapping between the projectile and the tube?—I have had no experience with respect to the length of time a gun rifled on the hexagonal principle will last, but I think there can be very little doubt that a polygrove gun, with a lead-coated projectile, would last longest. If it is a well-made gun, we do not find that it wears out at all; there is no sign of it.

192. The weakness is in the vent-piece?—Yes.

193. Have you seen any plan before the Ordnance Select Committee lately for remedying that?—I have seen the plan proposed by Mr. Westley Richards.

194. Do you think that that plan holds out any hope of a remedy for that defect?—Yes, I think it does.

195. Supposing the guns to be of equal bore, which is the better gun for sea or land service, the breech-loader or the muzzle-loader, in your opinion?—For sea service, the heavier the projectile, the more desirable it is to have a breech-loader, if you can get a safe one.

196. The evidence of Colonel Gardner, who was recently examined before this Committee, led us to understand that there was an impression in favour of smooth-bored guns as being superior to rifled guns for many of the purposes of war; are you of that opinion?—Certainly not; although I would not altogether discontinue the use of smooth-bored guns at present.

197. Has not a rifled gun the power of doing all that a smooth-bored gun can do, and at the same time the additional power of precision of range?—Yes; taking a rifled 110-pounder with a 68-pound shot, firing that with a 16-pound charge, we produce as great an effect upon iron plates as with a 68-pounder smooth-bored gun with the same charge and weight of shot.

198. Supposing that in the breech-loading system in the larger guns there were found no remedy for that weakness in the vent-pieces, is it still the fact that Sir William Armstrong has produced a muzzle-loading gun, which has the advantage of interposing a soft substance between the tube and the shot, and so avoiding friction?—Yes, he has.

199. Does that appear to you to be a good description of muzzle-loading rifled gun?—There are many other systems of muzzle-loading that I prefer to it, but we have lately carried out numerous experiments by the direction of the Secretary of State for War, with a view to find out the best mode of rifling, in the event of the Government deciding on rifling cast-iron guns. We have gone very carefully into the question in our report, and you will find all the information you require in that report, if the Secretary of State for War will permit you to have it.

200. Captain *Jervis.*] What is the service charge for Sir William Armstrong's 100-pounder?—Fourteen pounds.

201. I observe, that in the experiments that are going on at Shoeburyness, the charge for Mr. Whitworth's 110-pounders is 25 lbs. of powder?—It is 25 lbs.

202. Is that to be the service charge for the gun?—I do not know at all; we have never been able to ascertain from Mr. Whitworth what he intends his service charge to be.

203. But let me ask you, as a Member of the Committee; have there been no trials to ascertain what amount of rounds a gun like that would stand, with 25 lbs. of powder each time?—None at all.

204. Colonel *Dunne.*] Are not those two guns, to which the respective charges of 14 lbs. and 25 lbs. apply, of the same calibre and weight of shot; are they not both 70-pounders?—No; one is an Armstrong 110-pounder, weighing 84 cwt; the other a Whitworth 130-pounder, weighing 148 cwt.

205. What is the service charge of the Armstrong gun?—14 lbs.

206. What is the weight of the shot?—110 lbs.

207. And the Whitworth is how much?—For the 148 lb. shot the charge is 25 lbs.

208. Sir *John Hay.*] Have you seen the report made by Colonel Strange on the condition of the 7-in. Whitworth gun, which was made at Woolwich on Sir William Armstrong's coil principle?—I have seen the impressions.

209. What is the condition of that gun?—I cannot give you the exact size of the indentations, but I do not think that it would be safe to fire the gun many more rounds.

210. How often has that been fired?—I cannot quite tell you, it is not in our hands at all.

211. Has it been fired 100 times?—I think not.

212. Has it been fired 50 times?—I think not.

213. Has it been fired 30 times?—I can hardly say, but I should say not more than 20 times.

214. Colonel *Dunne.*] It cannot fire many rounds more, can it?—Not without being repaired.

215. Sir *John Hay.*] Will you state generally, what is the condition of the gun?—I could not; I merely saw it in the impressions in the commandant's office.

216. Is it damaged by the explosion of the powder, or damaged by the friction of the shot?—I imagine that it is damaged by the explosion of the powder.

217. And also by the friction of the shot?—And also by the friction of the shot, but the gun is not in our hands.

218. Captain *Jervis.*] If you carry on experiments with a charge which you cannot adopt as the service charge, is not that giving a very false impression of a piece of ordnance?—Very false indeed.

219. From which you can gather no fair deduction whatever?—Not the slightest.

220. I suppose the adoption of the small charge of ammunition of Sir William Armstrong was come to, after repeated experiments?—The charge of the 110-pounder has been 14 lb. ever since it was finally introduced into the service.

221. Colonel *Dunne.*] Do you know that the guns at Shoeburyness were fired with a great variety of experimental charges?—Yes.

222. Are you aware how many rounds a gun will last exposed to those charges, take for instance, the life of the Armstrong guns?—I am not aware of any gun having been so damaged by

by those high exceptional charges, that it has not been easily repaired, and the gun used afterwards.

223. Sir *John Hay.*] Has it been used afterwards as a service gun?—No gun which has been damaged in this way would be issued for service.

224. Colonel *Dunne.*] Can you state in what length of time a gun will become damaged?—Unless from accidents, I do not think any number of rounds will damage it.

225. And fired with the service charge, you think these are very lasting guns?—Yes, and I believe the life of the vent piece might be easily ascertained.

226. Captain *Jervis.*] Have you heard that there have been reports circulated of late that a great many Armstrong guns used in the service have proved very unsatisfactory?—Yes.

227. Are you aware of the cause?—I suppose it is from bad manufacture; I can only suppose that.

228. Do you consider that, if the guns had been carefully manufactured according to the pattern decided on by the Ordnance Select Committee, those failures would not have arisen?—Certainly not. I could put in a report of the number of rounds and tests we have put these guns to. We have never had a gun damaged at all.

229. Whether made at Elswick, or, in fact, at Woolwich?—No.

230. Mr. *Beecroft.*] Do you know whether the guns which are said to have failed have failed in the welding of the coil?—I believe they have.

231. Captain *Jervis.*] If they had been carefully inspected in the course of manufacture you think that could not have arisen?—I think not.

232. Mr. *Laird.*] Who inspected them during their manufacture?—I do not know; I presume the different foremen employed in the factory did.

233. Who was at the head of the factory?—The nominal head was Sir William Armstrong; but the actual head of the factory was Mr. Anderson.

234. But Sir William Armstrong would, of course, be responsible for all the guns issued from the factory?—I presume so.

235. Mr. *Beecroft.*] Is it not very difficult to get the coils uniformly welded?—I can hardly answer that question; but I think Mr. Anderson will tell you that it is not.

236. But the larger the gun the greater the difficulty?—No doubt.

237. Do you find the defect mostly in the larger guns?—No; I think of late it is mostly in the field guns.

238. Did not that arise from some other cause?—The committee appointed by the Commander-in-Chief carried on, I think, many experiments at Shorncliffe, Portsmouth, and different places, where accidents have happened, and I fancy their report would tell you much more than I can, on that subject.

239. *Chairman.*] By whom were the guns which were made in the Royal gun factory at Woolwich inspected?—I suppose by Mr. Anderson, the head of the factory.

240. Is there no artillery officer there, whose business it is to inspect them?—There is an artillery officer for the inspection of the Elswick guns.

241. But not those made in the Royal gun factory?—No.

242. General *Peel.*] There is an artillery officer at Elswick?—Yes, there is an artillery officer at Elswick.

243. In order to superintend the course of the manufacture, and to prove the guns there?—Yes.

244. But he was there before the guns were proved at Elswick, was he not?—Yes; to superintend the manufacture of the guns and fuses, I presume.

245. Is it your opinion that the proof which is now applied is not sufficient to test the merits of the gun?—Quite sufficient.

246. It is from a fault occurring in the process of proof, if a defective gun is allowed to pass, you think?—I have nothing to do with the proof, therefore I cannot say. Our committee laid down, with the approbation of the Secretary of State, what the proof was to be; but we have nothing to do with carrying it out.

247. Do you consider that if the proof laid down by your Committee was carried out, it would be sufficient to test the gun?—Yes; I think it ought to be.

248. Mr. *Laird.*] Then, if the proof you laid down was sufficient, it must be the fault of the party who inspected the guns before delivery, if defective guns were issued?—I should not like to say.

249. It cannot be supposed that guns should be received and paid for, unless they had passed the proof which you consider sufficient?—I believe they never are.

250. Then, if they had passed the proof, and yet turned out not to be efficient, would it not follow that the party inspecting them had not taken proper care to see that the goods delivered were of proper quality?—If the proof laid down was sufficient, I cannot account for accidents happening in any other way.

251. Except by neglect in the supervision?—I cannot speak with regard to that.

252. General *Peel.*] The guns would not be able to pass the proof, if there had been that neglect?—I consider not.

253. Mr. *Laird.*] You have already stated that you considered the proof sufficient?—We considered the proof severe enough, and of late the Secretary of State has approved of a proposal to alter the mode of proof of rifled guns.

254. That only tends further to show, that if your proof had been carried out it would have secured good guns for the service?—I think so.

255. Colonel *Dunne.*] But a gun may pass the proof, and at the next shot it may burst?—That may occur.

256. Captain *Jervis.*] Do you know if the guns that are now complained of are guns that had not passed the proof, and were tinkered up afterwards, previously to being sent into the service?—I do not know.

257. But that is the general impression, is it not?—It is.

258. *Chairman.*] Your impression is, that guns manufactured in the Royal gun factory at Woolwich, where a civilian is at the head of the department, have been received into the service without having been seen or inspected in any way whatever by an artillery officer?—I believe so.

259. Mr. *Laird.*] Are you aware whether the guns found inefficient were guns made at Woolwich, and passed by Sir William Armstrong, or made at Elswick, and passed by the artillery officer there?—I do not know.

260. Could that be ascertained?—Quite easily, from the storekeeper.

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261. Do you think that guns have been received into the service that have been patched up after not passing proof?—That is the general impression, but I do not know it.

262. Captain *Jervis.*] What I understand you to say is, that guns made at Elswick are always proved by an independent party in the shape of an artillery officer?—Yes.

263. Sir *George C. Lewis.*] But in the case of the guns manufactured at Woolwich, there is no inspection by an artillery officer?—There is no inspection, except by the head of the department.

264. Captain *Jervis.*] Do you know exactly the position that Sir William Armstrong held in the Royal gun factory?—No.

265. Major *O'Reilly.*] I think you said, that when your Committee was appointed there were only two systems of rifling that you considered worth examining into, Mr. Whitworth's and Sir William Armstrong's?—Not exactly, but we placed those by themselves as being infinitely superior to the rest.

266. And you stated, that as to his system of rifling Mr. Whitworth was at that time quite decided, but with regard to projectiles and fuses he was not prepared with perfected plans?—Yes.

267. Now, what I wish to ask is, did you, before you reported on that committee, thoroughly examine the two systems with regard to their comparative excellency on the point of rifling?—We did, certainly.

268. And you came to the conclusion that Sir William Armstrong's system was the best?—Yes, we came to the conclusion that his system was the best.

269. I see in the report of that committee, that one great objection to Mr. Whitworth's gun was that it required careful washing and drying; does that objection apply to Sir William Armstrong's muzzle-loader, or shunt gun?—A damp sponge is generally used with it, but I believe that difficulty may be got over if a proper lubricating wad is used.

270. But the fact being that one reason assigned in that report of 1858 for rejecting Mr. Whitworth's gun was the necessity of careful washing and drying; let us again ask, does that objection apply equally to Sir William Armstrong's muzzle-loader?—At that time Sir William Armstrong had no muzzle-loader, but I believe now it does equally apply.

271. Do you think that that objection has still the same weight with regard to all muzzle-loaders, as you did then?—I think a system that did not require it would have one very great point in its favour.

272. You mentioned also, that in the course of those experiments, you travelled ammunition 500 miles, in order to test its power of travelling; may I ask if you have seen the reports from China?—I have.

273. Do you think that they confirm or disprove the conclusions you came to as to the travelling qualities of that ammunition?—I think the principal damage that the ammunition received which went to China was on board ship, and in embarking and disembarking from the ship, not from land travelling at all.

274. Now, with respect to fuses; you have also seen the reports; am I right in summing them up into the fact that the time fuses were almost always unavailable for service?—They were very bad indeed; I think that has been admitted by the withdrawal of them from the service, superior ones having been substituted for them.

275. But when you reported in 1858, they were supposed to be good?—No fault was found with the fuses when they were first manufactured, but they very rapidly deteriorated, and we had not them long enough under trial to test them. They were adopted as part of Sir William Armstrong's system, and you could not have adopted his shell without the fuse.

276. Do you consider the concussion fuses are successful?—They are now.

277. But not those used in China?—They were not nearly so good as those we have in the service now.

278. With the muzzle-loader is there a necessity for the use of those special time, or concussion fuses?—There is always occasion for a good concussion fuse, but the ordinary time fuse will answer in that case.

279. Is that an advantage?—A great advantage; that is one of the advantages of the muzzle-loader over the breech-loader.

280. You have, also said, I think, that Sir William Armstrong's guns were the best with respect to range and accuracy?—That they were equal to any guns I have seen since, and superior to most of them.

281. Colonel *Dunne.*] What gun have you seen that is equal to Sir William Armstrong's?—From what I have seen of Mr. Whitworth's guns, I think his guns are quite equal in range and accuracy, but I have had very little opportunity of seeing them.

282. Major *O'Reilly.*] I think you have stated that the breech-loading gun was the best for sea service; do you consider the breech-loader best for field service?—I am hardly able to give an opinion, not being an artillery officer; but I think, speaking from the little practice we have in ships with field guns, dragged by men, that I should prefer the breech-loader to the muzzle-loader, if it were as safe as field guns are now.

283. Do you or not wish to express an opinion generally, taking all the incidents of campaigning into account, whether the breech-loader is superior to the muzzle-loader for field service?—I am hardly able to give an opinion; it is quite a military question.

284. Captain *Jervis.*] You have field guns on board men-of-war?—Yes.

285. You do sometimes land them, and I understand you to convey to the Committee that you would be ready to land them for service?—Yes.

286. Is there any complication in the Armstrong gun which would prevent its being manipulated by seamen as easily as if it were a muzzle-loader?—I think not; there is a disadvantage in landing it; there is the vent-piece to take care of, and the breechs-crew may be separated; but from experience in landing field guns, I do not think there would be any difficulty in it, or any chance of part of the gun being left behind.

287. You do not find that is a complicated gun for seamen to handle?—No.

288. Major *O'Reilly.*] Does your answer apply to service, such as landing those guns from ships, but not to using them in long campaigns by land?—Yes; my answer applies to ordinary service in landing guns from ships. I do not like to venture to give an opinion with respect to campaigning.

289. Colonel

289. Colonel Gardner stated, I think, that as many as 60 or 70 vent-pieces had been broken, and that frequently two or three were broken in a very short time; do you consider that that inconvenience has now been thoroughly remedied?—No, I think not. In the larger natures of guns the vent-pieces are still breaking.

290. Has it not been stated that some of the vent-pieces were broken in China in the 12-pounder guns?—I am not sure; I think they were blown out, not broken. However, they were vent-pieces of the old form, which were very liable to be blown out.

291. That particular liability is now remedied?—I think so.

292. Colonel *Dunne.*] Up to what calibre do you say the guns are now superior to any other? Do I not understand you to say that you have not the same good opinion of the heavy guns as of the lighter ones?—I have a very high opinion of the heavy guns; and though they have the disadvantage of breaking their vent-pieces, I still think their advantages are so very great that it is a question whether they do not outweigh that single disadvantage. I think that up to the 40-pounder the guns are now very perfect.

293. Beyond that point do you think there is any gun that is made which is not susceptible of a very large degree of improvement?—I think all the larger natures of guns will have to be very much improved before you introduce them for service.

294. That answer refers to guns of anybody's construction, does it?—Yes; to anybody's guns.

295. Do you think that in guns of the smaller nature, Mr. Whitworth's are so superior that, having already got Sir William Armstrong's in the service, we should change them into Whitworth guns?—I have had very little experience with Mr. Whitworth's last system of projectiles, but I do not think there is any such superiority as would justify the change you refer to.

296. Mr. *Baring.*] In your opinion, does the defect of the vent-piece arise from the difficulty of obtaining the right quality of metal?—From the difficulty of obtaining the right quality of metal.

297. Do you foresee any probability of that difficulty being obviated?—I have no doubt it will, but I think it will take a long time to do so. Frequently we have been told by Sir William Armstrong that he has discovered some particular metal that has got rid of the chance of the vent-piece breaking, and for some little while all has gone on very well, but then, after a time, we find the vent-pieces breaking again.

298. With respect to the proof of the Armstrong guns, do you consider that any damage that has occurred to them may have arisen from the proof being excessive?—I, myself, think not, but many scientific people do think that we put in too high a charge of powder. The experimental charge used to be double the service charge. Some time ago we invited the opinions of particular people whom we thought competent to judge upon the subject; and from their opinions, and the results of our own experience, we recommended a change, and reduced the quantity of powder used in proof.

299. Sir *George C. Lewis.*] Was it not found that the defect in the mode of proof arose, not so much from the strength of the double charge of powder, as from its bulk, which brought it forward too much in the gun, and strained a portion of the gun which was weak?—That was the great objection to a double charge of powder; the exceeding length of the cartridge brought the shot and the front part of the cartridge into a part of the gun which it was not necessary to strengthen for ordinary service rounds.

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300. Therefore, a part of the gun was subjected to a very severe proof, which, under ordinary circumstances, would not have been exposed to so severe a trial?—That was it.

301. Mr. *Laird.*] I think you suggested that there would be a difficulty in changing from one description of gun to another, if a change were found necessary?—I suppose that there would be an enormous expense to the country in doing so.

302. But if the machinery employed in the manufacture of the guns were adapted to both kinds of guns, would there be much difficulty in it?—I imagine that there would be a very great difficulty, because the ammunition is so different; you would have to change at every part of the world, where we have depôts, the ammunition of every description.

303. You think that, unless some very decided advantage could be secured by a change, there would be no gain to the country sufficient to justify an alteration?—Certainly not.

304. Even allowing for the disadvantage which you have mentioned?—Even with that disadvantage.

305. Can you tell me what was the usual charge with the old guns?—For a 68-pounder smooth-bored gun the charge was 16 lbs.

306. What was the proof charge for the same gun?—For a 68-pounder smooth-bored gun the proof charge was 28 lbs. Originally the charge of a 68-pounder was 14 lbs.; the proof charge was then arranged at 28 lbs., or double the service charge. Afterwards the service charge was increased to 16 lbs., but the proof charge was not increased.

307. Then the charge used with Sir William Armstrong's guns was not, in proportion, more than is used with common guns?—Certainly not.

308. And it was not thought excessive by your Committee?—Not the service charge.

309. Sir *John Hay.*] Will you inform the Committee what is the weight of the 10-inch shell used in the service?—It ought to be 84 lbs.

310. Does that include the bursting charge?—No; I may be wrong, however, in giving that as the exact weight.

311. If any considerable divergence took place in the weight of the shells, would any disadvantage arise?—It would bring a very great deal more strain upon your gun-carriage, slide, breeching and tackles, and your range table would be found incorrect.

312. What amount of difference in the weight of the shell, in proportion to its gross weight, would you suppose might be allowed with impunity?—I think there is a limit of weight laid down, which I suppose has been very carefully considered, and should not be exceeded, but I cannot quite say what it is.

313. Suppose it were shown that those shells were supplied, weighing 95 lbs., instead of 84 lbs., a considerable difficulty might arise in case of war?—I am quite certain of it; it would have a very serious effect.

314. *Chairman.*] Is there anything else you wish to state to the Committee?—No.

Colonel CHARLES BINGHAM, called in; and Examined.

Colonel *C. Bingham.*

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315. *Chairman.*] WHAT official position do you occupy?—Deputy Adjutant General of Artillery.

316. What are your duties in reference to field guns?—I am responsible to the Commander in Chief for the whole of the field artillery which is in the possession of the Royal Artillery.

317. Do all the reports come to you of practice, and of the trials all over the country?—Yes; practice and trials of all kinds.

318. Have you been yourself present at any of the recent trials that have been directed to be made by the Commander in Chief?—Almost all of them.

319. Were you present at the trial at Shorncliffe of the Armstrong gun?—Yes.

320. Another trial was at Shorncliffe between the Armstrong and the Whitworth gun?—Yes.

321. Another at Portsmouth?—Yes.

322. You were present at all three?—At all of them.

323. How many guns were tried: take the first trial at Shorncliffe; how many were tried there?—Twelve.

324. How many rounds were fired there?—One hundred per gun.

325. Was it rapid firing?—As fast as it could be; we laid out the targets at from 200 to 3,000 yards; we imagined an enemy advancing and retreating, and fired accordingly; the firing was as fast as it would have been in any actual service.

326. How long did the trials take?—About two hours at Shorncliffe.

327. Will you be kind enough to state the results of those trials?—At the practice at Shorncliffe there were 12 guns used; and they fired in that way their 100 rounds as rapidly as they could, and with wonderful precision; for the whole of the targets were carried away except those at 3,000 yards, and they were hit several times; there was not an accident of any sort or kind to screw, bolt, or gun that could be visible to any one.

328. Was there no accident to the vent pieces?—None at all; not the slightest.

329. At Portsmouth you were also present?—Yes; and there were 12 guns fired, firing 123 rounds a gun.

330. How long did that occupy?—About an hour and 20 minutes.

331. What was the result?—The result on the whole was satisfactory; one vent-piece was broken in one of the guns, but that was all of any real consequence that happened in the way of accident; the only breakage.

332. There was only one vent-piece broken?—Only one.

333. Were the guns that you tried at Portsmouth guns that had been there some time, or were they sent down specially?—Six of them belonged to one of the field batteries, and six were sent down from Woolwich.

334. In which of those was it that the accident occurred?—One that came from Woolwich.

335. Have you any opinion with respect to the cause of the accident to that gun?—It was the first round fired with that vent-piece, and we thought that the frost might have had some connexion with the accident; it was one of the old vent-pieces, not one of the new ones.

336. Do you consider that it could have been thoroughly inspected before it came down?—I cannot tell you; it came from the Arsenal, and was issued in the usual way

337. And it went at the first shot?—It went at the first shot.

338. Colonel *Dunne.*] There can be no doubt that it had been proved, I suppose?—We were not at all sure; it was issued from the Arsenal.

339. *Chairman.*] Were the results with regard to shells and fuses generally satisfactory?—We did not expect any great results, for we knew that all the ammunition was obsolete.

340. Those experiments were made with obsolete ammunition?—They were made with obsolete ammunition to try the powers of the gun.

341. You stated also that you were present yourself when those experiments were made between the Whitworth and Armstrong gun at Shorncliffe?—Yes.

342. What was the result of those experiments?—There were three of Mr. Whitworth's guns and three of Sir William Armstrong's guns; they were 12-pounders.

343. Were they fired under the same conditions as you have previously mentioned?—They were not fired with the same kind of programme; each gun fired one hundred rounds, I think; there were six guns in all. The firing from Mr. Whitworth's gun was very good, but I do not think it was any better than the firing from Sir William Armstrong's guns.

344. Those Whitworth guns were old brass guns rifled according to the Whitworth's principle, were they not?—Yes.

345. Are you able to express an opinion as to whether, if an artillery officer had been at the head of the Royal Gun Factory at Woolwich, such an accident as you have described would have been likely to occur; I mean the accident with regard to that vent-piece at Portsmouth?—I do not think it could. I think if they had been properly inspected and proved the accident most likely would not have happened; but I will not say that it could not have happened.

346. General *Peel.*] Was there not an artillery officer at the head of the Royal Gun Factory before they began to rifle the guns?—Yes.

347. Were there not many failures in cast-iron guns at that time?—We never heard of any failures; but very few iron guns were issued to the service from the Arsenal. I know that iron guns received from contractors failed at proof very often.

348. *Chairman.*] Have any just complaints been made, to your knowledge, of the quality of the articles supplied from the Government factory, which are under Artillery officers?—Yes, I have heard complaints.

349. Will you mention what those complaints were?—One great complaint is about rockets. As far back as 1859 there was a complaint made about the rockets.

350. Would you state the substance of the complaints?—In 1859 a rocket burst at Aldershot, in practice, and killed a sergeant of the Horse Artillery. Orders were then given that no more rockets were to be fired, as they were not considered safe.

351. Was

351. Was that from faulty manufacture?—They burst in the tubes, so, I suppose, it was from faulty manufacture, and up to this date we have not had any satisfactory rocket introduced into the service.

352. The rockets have been under consideration for a great many years, have they not?—Yes, since 1859, certainly.

353. And a long time before that, were they not?—We always supposed them to be safe up to that time.

354. Can you mention any other complaint?—There was another complaint about the 10-inch shells. In August 1860, it was found that there were a great number of 10-inch shells in the service which were over the proper weight, 82 lbs.

355. You mean, that they were not made according to pattern?—They certainly were not according to weight; they might have been according to size.

356. Are you aware whether there are different kinds of 10-inch shells; one for the navy, and one for the army?—There is one for mortars, and one for guns.

357. But I want to know whether those shells were made according to the pattern, or whether they were not?—I cannot tell you.

358. Will you now proceed to mention any other complaint?—Those are the only two instances. I have heard a great many trivial complaints against carriages, about wheels breaking, and so on, but they were of no great consequence.

359. With all your experience, the only two serious complaints which you have heard of as being made against any articles manufactured in any establishment over which an artillery officer presided, were those two; the one with regard to the rockets in 1859, and the other with respect to those 10-inch shells?—Long ago the port fires in the service entirely failed.

360. How long ago is that?—That was in 1856 or 1857.

361. General *Peel.*] Were there not great complaints of the shells generally?—There were great complaints of the old Shrapnell shells.

362. *Chairman.*] When were the Shrapnell shells manufactured, against which those complaints were made?—In 1854 and 1855.

363. General *Peel.*] But were there not complaints of the shells that were substituted for the Shrapnell shells?—A great number.

364. *Chairman.*] But was the complaint with respect to the pattern, or the mode of manufacture?—I should think it was more the pattern.

365. Then that would have nothing to say to the question now under consideration?—No, I think not.

366. Will you state generally what your opinion is with respect to the Armstrong field guns?—In 1858, before they were introduced into the service, I had great opportunities of seeing them practised with and used at Shoeburyness. My duty constantly took me down there, and I always considered that it was the most powerful gun and the best rifled gun that there was. After it was introduced into the service there were a great many small changes made, and up to last autumn, I should say we had perfect confidence in the gun in every way, until at the ordinary practice at Shorncliffe, six of the guns became very much damaged—in fact, unserviceable. It was in consequence of those guns going wrong, that the Commander-in-Chief asked for those 100 rounds to be fired from various other guns, and the result was what I have told you, that at Portsmouth there was only one vent piece broken. At Dublin, two batteries of horse artillery fired 100 rounds a gun, and there was not the slightest accident of any sort or kind. But it was thought necessary by the Commander-in-Chief and the Secretary of State for War to order a committee of artillery officers to inquire into all the accidents that had happened with all the Armstrong guns. I was a member of that committee, with Brigadier General St. George and Colonel Taylor, and we went down to Portsmouth, and also to Shorncliffe, to see those guns, and we made a long report, which is now in the hands of the Secretary of State for War.

367. That report probably contains the substance of your opinion on the subject?—Entirely.

368. Would you be kind enough to state at greater length what that opinion was?—Our opinion was, that the whole of those accidents were attributable to bad manufacture, and were in no way the fault of the gun.

369. And to what circumstance did you attribute the bad manufacture?—We were informed that those guns, and not those only, but a great many other guns in the service, had proved faulty at the first proof, and then, to save expense, the faulty part was bored out, and a thin tube was introduced into it, and then it was rifled again, and it was supposed that this thin tube would have withstood all the resistance of firing; but instead of that, in some instances it slipped backward, and in some instances it slipped forward. I think they should never have been issued to the service.

370. Do you suppose they would have ever been introduced into the service, if the superintendent of the gun factory had been an artillery officer?—I do not think they would.

371. Then I may gather from your answers that your strong opinion is that the head of the gun factory ought to be an artillery officer?—Undoubtedly.

372. Mr. *Beecroft.*] Did those guns give way in the coil?—One did give way in the coil, and one of them burst in the side; one of them slipped away from the trunnions three-quarters of an inch.

373. Does not that show that the coil was not properly welded?—I am not mechanic enough to say, but I would suppose so.

374. General *Peel.*] If the service field guns are properly manufactured, are you perfectly satisfied with them?—Perfectly satisfied.

375. You think that no other country has a better field gun?—Certainly not.

376. *Chairman.*] Do you think with Colonel Gardner, that a considerable number of the field guns ought to be smooth-bored?—I think that for some purposes, such as rapid movements of horse artillery, the old smooth-bored gun was quite sufficiently good; but I think the main part of the artillery taking the field should be Armstrong guns, or rifled guns of some kind.

377. Mr. *Dodson.*] With regard to those guns that proved defective, were they manufactured at Elswick or at Woolwich?—They were manufactured in the Royal Gun Factory.

378. Captain *Jervis.*] I think you hinted that the guns were tinkered in that way to save expense; but the expense would have fallen upon the public if they were manufactured at Woolwich?—Of course it would.

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379. Sir *John Hay.*] Did the Ordnance Committee attribute blame to any one for issuing those imperfect guns?—No.

380. Nor indicated it?—No.

381. Sir *George C. Lewis.*] You were not instructed to express an opinion, but merely to report a fact?—Quite so.

382. General *Peel.*] Was it any part of your instructions to inquire whether there had been any proof at Woolwich at all?—No.

383. Sir *John Hay.*] What number of those guns were there introduced into the service?—Seven, I think, have gone wrong.

384. Have no other defective guns of that description been so introduced?—I believe that more than half of the guns we have now in the field service are those faulty guns.

385. Patched up on that faulty principle?—Patched up on that faulty principle.

386. There is a means of tracing those guns, and withdrawing them, is there not?—Yes.

387. Captain *Jervis.*] Do you know if there was any authority for this patching up?—I do not know.

388. Colonel *Dunne.*] Are you going to withdraw those faulty guns which are at this moment in the field batteries?—We are doing so; we have an order to change the whole of them.

389. Is there not this loss in not having smooth-bored guns, viz., that you cannot fire *en ricochet*?—We do not require what is generally understood as *ricochet* firing in the field. What I understand to be meant by *ricochet* firing, is with reduced charges and high angles of elevation for enfilade fire, and dismounting the guns of the enemy's works.

390. Not in the case of field work?—You would not use ordinary field guns for *ricochet* firing, but I believe those Armstrong guns *ricochet* very well, though I have not seen the experiment myself

391. Sir *John Hay.*] What are the largest guns that have been so doctored?—Twelve-pounders, so far as I know.

392. Not guns of any other description?—Not that I know of.

393. Captain *Jervis.*] Will you explain in what manner those guns were patched up?—I am not mechanic enough for that.

394. Was it by putting in a false bore?—I understood so; sometimes not right from one end to the other, and sometimes from end to end.

395. *Chairman.*] In other words, it was an adaptation of some new principle introduced by Sir William Armstrong to guns which had been manufactured according to his system, but manufactured some little time ago before that new principle was introduced?—No, it was not.

396. There was an old gun made according to Sir William Armstrong's pattern, which was manufactured at the Royal Arsenal, at Woolwich, and into that gun there was something introduced, and the introduction of that something you call "patching"?—No, not that. What I understood was, that after the guns were manufactured they were put to a sort of proof by the head of the manufacturing department, and at that proof they showed signs of weakness.

397. Sir *John Hay.*] By the head of the department, do you mean Sir William Armstrong?—No, I believe this was done by Mr. Anderson.

398. Sir *George C. Lewis.*] They were lined, and that lining was rifled?—Yes.

399. General *Peel.*] When were the rifled guns first issued?—At the expedition to China.

400. Are any of those guns still in use?—There is one of those batteries still in China.

401. Did any of the failures attach to those guns?—Not that I know of.

402. It is only subsequently that the failures have taken place?—It is to the guns issued for field service within a year and a half that those accidents have happened.

403. Sir *John Hay.*] Do you attribute that discredit which is attached to a certain number of the guns supposed to have been manufactured on Sir William Armstrong's principle, to the fact that his principle was not carried out fairly at the gun factory, but that the guns were patched up and issued as if they had been manufactured on Sir William Armstrong's principle?—I suppose so.

404. Sir *G. C. Lewis.*] Do you not suppose that Sir William Armstrong was cognisant of the facts?—I suppose so.

405. He was the head of the department, was he not?—Yes.

406. And you suppose this manipulation was conducted under his immediate superintendence?—I have no reason to know it.

407. And if he did not know what was going on, he might have known by inquiring, might not he?—Of course he might.

408. Mr. *Laird.*] Sir William Armstrong was, you are aware, the head of the department?—Yes.

409. Do you think that he would have issued guns on his own principle which were inefficient?—I cannot say.

410. You think that all guns manufactured ought to be proved by an artillery officer?—Yes.

411. Do you think that an artillery officer is any better than an engineer, or any other party who understands his business?—I think that, as an officer, he is so responsible that he would never have allowed guns manufactured in this way to be issued to the service.

412. *Chairman.*] You think that he, having superintended the manufacture from the beginning, would have known exactly what was wrong?—If he had known what was wrong, he would not have let the guns go out.

413. Sir *John Hay.*] The responsibility might some day fall upon himself, if he were called upon to take the field?—Yes.

414. Mr. *Laird.*] Do I understand you to say that you think Mr. Anderson, unknown to Sir William Armstrong, patched up and issued those inefficient guns?—I cannot say that.

415. Captain *Jervis.*] And should he have done so, it would have been sanctioned by Sir William Armstrong?—I cannot say; I merely know the fact that the guns were issued.

416. Mr. *Laird.*] Is Mr. Anderson the judge who decides what guns should be issued?—The head of the department decides that.

417. Then Sir William Armstrong must have decided that those guns, after being repaired or altered in that way by Mr. Anderson, were efficient guns?—I presume so.

418. Captain *Jervis.*] But are they not bound to be manufactured according to the sealed pattern?—Nobody can tell whether they are or not.

419. But there is a sealed pattern, and they ought to be manufactured according to that pattern, ought they not?—Yes.

420. And no deviation ought to take place without proper authority?—None whatever.

421. Mr. *Beecroft.*] May I ask you if a gun showed any deficiency after being proved, would you, in that case, recommend that the gun should be condemned, or patched up?—I should say condemned altogether.

422. For purposes of safety?—For purposes of safety, and for the credit and efficiency of the service.

423. *Chairman.*] It would be so if the guns were made by a contractor?—Undoubtedly.

424. Mr. *Laird.*] I understand you to say, that no complaints have been made of the old cast-iron guns after being issued?—No complaints as to their manufacture, but they burst sometimes.

425. But you said that there were no complaints of the old cast-iron guns after being issued, did you not?—Not with regard to manufacture; but after a certain number of rounds they burst, though that was a very rare thing.

426. You think that it would be a better check if the projectiles were made by contract, and passed by artillery officers?—I think all munition of war should be passed by officers of artillery.

427. Mr. *Baring.*] The opinion which you expressed with regard to the necessity of proving guns by an artillery officer amounts to this: that some one, independent of the manufacture, should be answerable for the guns being fit for the public service?—Certainly, some responsible person.

428. Is that opinion of yours confined to any one department, or does it extend to them all?—I should like to have the whole of the department under inspection.

429. That is to say, that some inspection, independent of the manufacture, should take place at all the departments?—Yes.

430. You would make no difference as to whether the head of the department was, or was not, an officer of artillery?—No.

431. *Chairman.*] But I thought you said, that you had found hardly any complaints against the articles manufactured in those departments, where the head was an artillery officer?—I mentioned one very serious complaint in one department; and there were small endless complaints from others. In my idea it would be better to fix the responsibility on one person.

432. Do you think if, instead of having the head of each department individually responsible, you had some artillery officer at Woolwich who was to inspect the stores at all the departments; that would be an approach to individual responsibility, and not a departure from individual responsibility?—I think it would be well to have one person responsible for the whole of the war material manufactured by the Government.

433. Mr. *Baring.*] Do you mean responsible for the proof of it?—I would make him responsible for the efficiency of it.

434. *Chairman.*] Let us test that by taking in the first instance the Royal Laboratory; you have been in your present office for many years, have you not?—Yes.

435. And you have been cognizant of these matters for the whole of that time?—Yes.

436. And during the whole of that time there have been only two complaints made against the Royal Laboratory, one was about the rockets, and the other with regard to the 10-inch shell?—Yes, and there was also the case of the port fires.

437. You are aware that during that period there has been an enormous quantity of material manufactured in the Royal Laboratory?—Yes.

438. And a far greater expenditure, even six or eight times as much, as there has ever been before in the same time?—Certainly.

439. Then, upon the whole, do you consider that the system has worked so unsatisfactorily that you would wish to change it?—No, I cannot say that.

440. Then if you do not consider that the system works unsatisfactorily, why do you wish to make any alteration?—I did not intend my remarks to apply specially to the Royal Laboratory, or the gun factory, or any particular department: I only think the system would work better if one person were responsible to the Secretary of State for War for the whole of the war material.

441. But, being anxious to discover the reasons on which your opinion is founded, I individualise the question, and taking the Royal Laboratory as an instance, I ask why, considering the system has worked so satisfactorily, you wish to alter it?—I think you would ensure more uniformity, and that there would be no power of introducing anything that was not sanctioned by the Secretary of State for War, or of altering a pattern of any sort or kind.

442. Then has there been during the period you speak of any alteration of a pattern, or introduction of a new pattern, without the consent of the Secretary of State for War?—I cannot say exactly that there have been, but there have been a great many articles manufactured that were not notified to the regiments of artillery, which might have led to a great deal of mischief.

443. Whose duty was it to signify those alterations to you?—I cannot tell.

444. Not surely the duty of the superintendent of the Laboratory, but of the officers of the Secretary of State for War, so that the complaint you make attaches not to the superintendent of the Royal Laboratory, or any other department, but to the office I have referred to, does it not?—No; to the Select Committee, if they knew of the alterations.

445. But, at all events, it does not attach to the head of the department, so that I should still be glad if you would explain to the Committee what practical inconvenience has arisen which induces you to desire that an alteration should be made?—I know that, for instance, if an armament is ordered for a particular fortress, and an order is sent down to the Arsenal for it, it may happen that two or three orders are sent down at the same time; there is no proper directing head to say which of those orders is to be finished first; and, perhaps, at the Royal Gun Factory, they begin with one of them, at the carriage factory they begin with another, and at the Laboratory they begin with another. That arises from their being no proper head to conduct the work smoothly.

446. And are not those precisely the arguments on which the appointment of the Director of Ordnance was founded; was it not for the very purpose of the giving of those orders, and the apportioning of them to the different departments?—I never understood that.

447. But is not that part of the duty of the Director of Ordnance?—Not that I know of.

448. Sir *George Cornewall Lewis.*] Is not the Director General of Ordnance constantly in the War Office?—Yes.

449. It would therefore be impossible for him to.

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to exercise to any considerable extent a personal superintendence over the manufactory at Woolwich, would it not?—Impossible.

450. Does not the present system assume that the head of the manufacturing department at Woolwich is infallible?—Quite so.

451. It assumes that it is impossible that he should commit any error of judgment, or that his vigilance should ever sleep?—Yes.

452. Do you think that is a safe principle of administration; is it not rather generally assumed that some check, or some control in the nature of an inspection, is desirable under similar circumstances?—That is what I have been saying; I am strongly of opinion that there should be an officer at the head of the Arsenal responsible to the country and the service, so that no doubts could exist as to the proper inspection or pattern of any article therein manufactured.

453. *Chairman.*] Is there not a control already exercised. Suppose that any article manufactured at the Royal Laboratory, or in the carriage department, turns out to be defective when it is issued to the service, is not that defect reported to you, so that you have full cognizance of the defect?—Quite so, when it is discovered.

454. The point to which you were directing your attention, when the Secretary of State for War asked you a question just now, was rather this: that you found a defect in the present organization, because there was no one to apportion the work to the different departments at Woolwich, when there were various orders sent down; but is not that apportioning one of the duties which the Director of Ordnance should discharge; must he not say, "You must manufacture the fuses before you make the shells, or you must manufacture the carriages for the field service before you manufacture the carriages for the guns of position"?—He could do that, but he could not be personally responsible, if he were always in the War Office, as he is now.

455. But if he gave an order, you would naturally suppose that that order would be obeyed, and would he not have the means of finding out if it had not been obeyed?—I suppose he would.

456. Therefore, if he discharged the duty which I now speak of, the difficulty which you first mentioned would surely fall to the ground?—I do not think that the works would be so satisfactorily carried out.

457. But, during the number of years you have been in the position which you now occupy, you have practically, one may say, no complaint to make. Have you ever found that there has been, when you have made a request for shells, or fuses, or anything of that sort, a difficulty in obtaining them?—That would not come under my notice.

458. Have any complaints been made by officers of artillery that they were not duly supplied with the articles which they required, or that they were not manufactured with sufficient rapidity?—No.

459. Sir *John Hay.*] What you desire is a better superintendence of the present manufacturing system, which you think requires more efficient inspection?—Yes.

460. The mischief arising from insufficient inspection is only found out when it is too late?—Yes.

461. And that, I suppose, might be fatal in war?—Yes.

462. Has there been, to your knowledge, any case in which the officers in charge of the manufacturing department at Woolwich (I do not say whether rightly or wrongly) have decided, contrary to the advice of the Ordnance Committee given to the Secretary of State for War, to alter slightly the pattern which had been introduced?—I could not answer that; I believe there has been.

463. Do you know whether a case ever arose in which the projectiles for a certain description of gun were made a little too large, so as to reduce the windage of the gun itself, which, in the other department, was made a little too small, so that when the two articles were brought together, it was found that the two officers had so arranged matters, that the projectiles would not enter the gun?—I have understood that that was the case.

464. At all events you think such a thing might occur under the present system?—Yes.

465. And to obviate that, you think it would be desirable to have an efficient inspection over the two or three departments, so as to bring their products together in a manner adapted for the service?—That is entirely what I mean.

466. Alluding again for a moment to what I mentioned just now, and which I only used as a means of evincing your opinion, can you state when the instance to which I referred was said to have taken place?—I should think about two years ago.

467. *Chairman.*] Can you state which would have been the two departments that were concerned, supposing such a thing to have occurred?—I believe the two departments were the Royal Laboratory and the gun factory.

468. Mr. *Laird.*] Do you consider that, if an artillery officer had been at the head of the Woolwich gun factory, those defective guns would not have been issued?—Certainly not.

469. That implies that the late management was bad, does it not?—I always thought that the artillery officer never should have been removed.

470. In addition to having artillery officers at the head of each ordnance department, you propose to have another artillery officer to check the head of the gun department and the laboratory?—I think there should be one artillery officer at the head of the Arsenal, who should be generally responsible for the efficiency of the whole of the manufacture of every sort of war material—responsible, I mean, to the Secretary of State that every thing was done according to pattern and specification.

471. You think there should be an artillery officer at the head of the gun department, another at the head of the laboratory, another at the head of the carriage department, and then an artillery officer placed over all three, to check their proceedings?—Yes; the first to be responsible to the head of the Arsenal, and he to the Secretary of State.

472. You think that the different departments of Woolwich should be placed under an artillery officer, and then that there should be a head over them, to check the whole?—Yes.

473. Sir *John Hay.*] So as to combine the manufactures in the different departments, and arrange that each of them should be efficient with reference to the manufactures of the other departments?—Quite so.

474. In order that the whole should be kept uniform?—Yes.

475. It

475. It is now quite possible, if patterns are departed from, that the manufacture in the Royal Laboratory, the manufacture in the carriage department, and the manufacture in the gun factory may, when brought together for the purposes of war, by no means coincide?—Yes.

476. And yet it is necessary, for the purposes of war, that they should all combine most accurately?—Yes.

477. But there is at present no means of supervision or inspection, which gives security that they should so combine?—No.

478. General *Peel.*] If there was that inspection it would be impossible that there should be any deviation from the pattern approved by the Secretary of State for War?—There ought not to be.

479. Sir *John Hay.*] And there would be a perfect responsibility in that case?—Yes.

480. Captain *Jervis.*] Taking the instance of those 10-inch shells, they were sent out to all parts of the world before it was found out that they were not made according to pattern?—Yes; to every station at home and most of the stations abroad.

481. And if I remember rightly, that was only found out by a carriage breaking down?—I do not know whether any carriage actually broke down or not, but it was found out upon the supposition that it would injure the carriages, and also the guns.

482. But did not the superintendent of the carriage factory write to explain how it was that he had made a bad carriage, and from that circumstance did not the facts come out about the 10-inch shells?—I do not remember; but it was mentioned to me by the inspector or head of the carriage department.

483. If there had been an independent inspection of those shells, they would not have been issued out of the Arsenal, you think?—I should think not.

484. Colonel *Dunne.*] Have you any doubt that it is better to have a military man than a civilian at the head of those departments?—I have no doubt at all about it.

485. Mr. *Baring.*] If you had an independent inspector, why should not a civilian be as able to conduct the departments as a military man?—I think there is a greater degree of responsibility with a military man than with a civilian.

486. Then the inspection, you think, would not be sufficient?—No, I think not.

487. And you think it necessary to have a military officer at the head of each department?—Yes.

488. General *Peel.*] Has not all the iron ordnance in the service been manufactured by contractors?—All of it.

489. And none of them were military men, were they?—No; but the guns were all subjected to a very severe proof; the old iron ordnance was subjected to a very severe proof.

490. *Chairman.*] Do you know how many guns burst at Swebourg?—I do not.

491. Mr. *Laird.*] They were overworked, were they not?—They were fired too quickly.

492. And that would be overworking a gun?—Yes.

493. Captain *Jervis.*] And they were so imbedded that there were no means of recording the results?—Beyond the fact that a great many of them burst, I do not know.

494. Mr. *Laird.*] I suppose the contractor could not be blamed if a gun had stood the proof?—No; but the proof of mortars is very different from the proof of guns.

495. Are you aware whether any complaints have been made of the management of the Royal Laboratory at Woolwich?—No; I have never heard any complaints.

496. You think the work is well looked after?—I believe it is very efficiently looked after.

497. Major *O'Reilly.*] I understand you to say that it is your opinion that one person should be responsible for the inspection of all military stores?—Yes.

498. Can an inspector, after the manufacture, ascertain the qualities of all military stores?—No; and that is why I want a military officer at the head of each department, and that one at the head of the whole Arsenal should be responsible for the whole being brought together.

499. Then would the man whom you put at the head of the whole of the departments be responsible or not for the quality of the projectiles, for instance, delivered out?—He would be.

500. Could he ascertain the quality of the projectiles by inspection?—He must place great confidence in the head of the department.

501. Then would it not be the head of the department who would be responsible for the quality of the projectiles?—He would be to a certain extent.

502. To what extent: surely, to the greatest extent. Can you tell whether a shell is right inside?—Yes.

503. A segment shell?—Yes, by breaking to pieces a certain number you could see whether the whole batch was well made.

504. Would it not be, practically, the head of the department who was responsible?—I suppose it would.

505. Captain *Jervis.*] But the head of the department cannot be present when every shell is made; he must trust his foreman?—Yes.

506. Major *O'Reilly.*] But with regard to guns, could an inspector, after the manufacture of an Armstrong gun, be accountable for all the manufacture?—The head of the Arsenal would put a gun through a very severe test, and would satisfy himself that it was properly manufactured.

507. Then the object would be simply to have the guns tested?—Yes, and to see that they were all according to pattern.

508. Sir *George C. Lewis.*] You stated that you thought if the inspection of the Royal Gun Factory had been efficient, the patched-up guns would not have been issued; do you consider that in this instance the duties of the inspector of that department were not efficiently performed?—I do not think they were.

509. Who is the inspector?—Sir William Armstrong.

510. The arguments which have been addressed to you assume that all inspection of military stores, after manufacture, is valueless?—Yes.

511. But if that were the case, would there be any advantage in inspecting goods or projectiles made by contractors?—I do not quite understand your question.

512. If all inspection after manufacture was worthless, would there be any advantage in an inspection of guns or projectiles made by contractors?—The same necessity would occur for inspecting all the articles delivered from the contractors.

513. But

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513. But I understand the object of the questions just put to you, and your answers, to be this, that unless the inspection were carried on during the whole process of manufacture, it was without value?—Yes.

514. But if that be the case, would it not follow that it was useless to inspect the guns or projectiles made by contractors?—Exactly.

515. But it is assumed, and taken as an axiom, that all guns and projectiles made by contractors must be inspected before being received into the service?—Yes.

516. Would it not therefore follow by necessity that an inspection after manufacture is of value?—Of course it is.

517. Sir *John Hay.*] And, therefore, it ought to be applied to the Government works as well as the contractors'?—Yes.

518. Captain *Jervis.*] It is a great source of complaint with contractors, is it not, that they fancy there is not fair play on both sides?—I know nothing about the contracts or contractors.

519. Major *O'Reilly.*] I think you stated that the gun whose vent piece broke at the first discharge, would not have broken if the vent piece had been properly inspected?—Not if the vent piece had been properly inspected.

520. Was not that the old pattern of vent piece?—Yes.

521. Have not a great many of the old pattern vent pieces been broken?—A great number.

522. Have they not been given up in consequence of their liability to break, irrespective of any fault in the manufacture?—I suppose the pattern of the vent pieces has been changed several times.

523. Might not that vent piece have broken without a fault in the manufacture?—It may have been so.

524. Colonel *Dunne.*] From your knowledge of the reports received from artillery officers of all classes, what is their opinion of the Armstrong gun, as compared with any other gun?—The general opinion is that the Armstrong field gun is the best rifled gun that there is anywhere in England or abroad.

525. General *Peel.*] Did you ever see the report that Colonel Lefroy and Captain Owen made after their return from Gibraltar and Malta, where they went to inspect the stores?—Yes.

526. Were there not a great many complaints of the stores there?—Yes, many complaints. That was owing a good deal to the changing the size or cone of the fuse holes, and there was a great confusion of fuses.

527. If there had been one inspector of stores such as you propose, that never could have happened?—I think not.

528. Had you afterwards to change the stores at your different artillery stations?—Yes, we had to make changes, in consequence of the different patterns of fuses and shells.

529. Sir *John Hay.*] In one answer that you gave on the subject of field artillery, you said that you would prefer generally, for campaigning, the Armstrong field guns, but that you thought, for horse artillery, the smooth-bored gun was sufficiently good?—Yes.

530. Am I to understand by "sufficiently good," that it is merely the economical question of using what we already have that causes you to prefer the smooth-bored gun for horse artillery; or that you would actually prefer the smooth-bored gun if both were offered to you?—I think horse artillery attached to cavalry, which requires very rapid movement, demands the simplest possible gun, and as the range is seldom beyond 200 or 300 yards, I think the old smooth-bored gun answers all purposes.

531. Better than the Armstrong guns, you think?—I think so, as being more simple.

532. For that purpose?—I think so.

533. *Chairman.*] You said just now that you considered the Armstrong field gun was the best gun that existed in the world at the present moment; but did I not rightly understand you to say, in answer to a further question, that you considered, from what you had lately seen, that the Whitworth gun was at least equal, though you did not think the country would be justified in going to the enormous expense of introducing a change?—I think that the Whitworth practice which I saw, with regard to range and accuracy of fire, was about equal; but there are many other points in favour of the Armstrong guns that Mr. Whitworth has not produced yet; he has not produced a satisfactory shell or fuse.

534. You still consider the Armstrong gun to be the best known gun?—Certainly.

535. Sir *John Hay.*] If you were to begin *de novo* to give rifled artillery to both services, would you prefer the Armstrong gun to the Whitworth gun?—As far as I have seen, I would.

536. And you have seen a great deal, have you not?—Yes.

537. Captain *Jervis.*] And you have obtained great information upon that matter by getting the reports of different officers of all the results obtained by them?—Yes.

538. Mr. *Beecroft.*] But you have seen more of the Armstrong gun than the Whitworth gun, have you not?—Yes; because very few of Mr. Whitworth's guns have been introduced or tried by the artillery at all.

539. Therefore you cannot make a fair comparison between the two guns?—No; as yet I do not say we have been able to judge; but hitherto Mr. Whitworth has not produced a shell or fuse; Sir William Armstrong has.

540. Captain *Jervis.*] Have you had any satisfactory report with respect to how the Armstrong guns behaved in Canada in marching up the country?—I saw them embarked in England without any particular care more than with any ordinary brass guns; they were landed in Halifax, and transported across to Quebec; and from the reports received from the officers, the guns seem to have been as ready for service in Quebec as they were when they left England.

541. Colonel *Dunne.*] You say that you prefer for horse artillery the smooth-bored gun; would there not be some difficulty in the shape of confusion of ammunition in having two kinds of gun?—Not the least. With the old smooth-bored gun we had four kinds of ammunition with every gun, and it was never found to create any difficulty.

542. You would have with rifled guns two advantages with regard to shell and shot, would you not?—No; they are all shells.

Lunæ, 23° *die Martii*, 1863.

MEMBERS PRESENT.

Mr. Baring.	Mr. Laird.
Mr. Beecroft.	Sir George C. Lewis.
Lord Robert Cecil.	Mr. Monsell.
Mr. Dodson.	Major O'Reilly.
Colonel Dunne.	General Peel.
Sir John Hay.	Sir Morton Peto.
Captain Jervis.	Sir Frederic Smith.

THE RIGHT HON. WILLIAM MONSELL, IN THE CHAIR.

JOHN ANDERSON, Esq., Examined.

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543. *Chairman.*] HAD you always been furnished with sealed drawings and specifications, or patterns, of the various Armstrong guns, before you had commenced to manufacture them for the service?—No.

544. Were you furnished with sealed drawings and specifications, or patterns, of the 12-pounder Armstrong gun for land service, before you commenced to manufacture it?—No.

545. How many 12-pounder land service Armstrong guns did you make before you received the authorised sealed pattern?—Almost the whole of the 12-pounders were made before the pattern was sealed, that is to say, the structure was set up; they were not quite finished, but the greater number were.

546. When was the pattern sealed?—On the 5th of May 1860 the pattern was sealed, and we commenced making guns in April 1859.

547. Will you describe generally to the Committee the construction, according to the sealed pattern in your possession, of the 12-pounder Armstrong gun, and point out in what particulars it differs from the guns which Colonel Bingham described as patched up guns with thin linings?—I did not hear the evidence to which you refer, and I do not know the meaning of the word "patched up."

548. At Question No. 369, Colonel Bingham was asked, "To what circumstance do you attribute the bad manufacture?" and he replied,—"We were informed that those guns, and not those only, but a great many other guns in the service, had proved faulty at the first proof, and then to save expense the faulty part was bored out, and a thin tube was introduced into it, and then it was rifled again, and it was supposed that this thin tube would have withstood all the resistance of firing; but instead of that in some instances it slipped backward, and in some instances it slipped forward. I think they should never have been issued to the service." With that explanation you can probably answer my question?—I should really like to go into this matter fully so as to make it clear, because I shall be able to convince the Committee to-day that the bouching was considered the right thing to do, and that not a single gun had failed in the bouching of the three which were said to have failed. I have brought drawings with me, and I shall show you that there is not the slightest thing the matter with their bouches, and indeed that but for those bouches some of the guns would have failed.

549. Your answer, then, would be, that there was no difference between the construction of the sealed pattern 12-pounder guns and the guns that Colonel Bingham describes as patched up?—The sealed pattern is a lined gun.

550. Then the sealed pattern is what Colonel Bingham described as a patched-up gun, with a thin lining?—Yes, but it is one of the best guns we ever made.

551. Do you know who were the parties that sealed this gun?—The Ordnance Select Committee.

552. Who else, do you know?—I am not aware exactly, but the Inspector of Artillery would have a word in it, perhaps.

553. Sir *John Hay.*] And the Secretary of State for War, I think?—Yes.

554. *Chairman.*] Had the Horse Guards anything to say to sealing the pattern?—They did not come before me.

555. Sir *Frederic Smith.*] Were there no names attached to the sealed pattern?—Yes, the Ordnance Select Committee's.

556. *Chairman.*] But is the name of the Ordnance Select Committee the only name that is attached to the sealing of the gun?—It is a very proper question to put, but I have never read the names that I see hanging to all the guns.

557. Sir *John Hay.*] It has a sign manual, has it not?—Yes.

558. Captain *Jervis.*] Are not all sealed patterns supposed to be sealed by the Crown, on the recommendation of the Secretary of State?—Yes.

559. General *Peel.*] I believe the Ordnance Select Committee merely recommend that a pattern be adopted?—Yes, that is all.

560. *Chairman.*] Had you manufactured any other kind of Armstrong guns before you received the sealed patterns and drawings?—We have almost always progressed for some distance with the guns before the pattern has been received. To take the case of the 9-pounders. It was only on the 9th of December, just about the time when the

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the "Trent" affair occurred, that it was resolved to make those 9-pounders, and I had the guns made in three weeks from the time the matter was first spoken about.

561. Keeping to the 12-pounders, do I understand you to say that the 12-pounder guns which you describe to be good and satisfactory, but which Colonel Bingham finds fault with, are guns that are made according to the sealed pattern, though you had not the sealed pattern; that is to say, the same guns as the guns of the sealed pattern?—The sealed pattern only refers to the exterior and interior surface and fittings; it does not apply to the structure. It would be a very injudicious thing to tie the manufacturer down to every detail of structure.

562. But the interior of the gun is the part found fault with; do I understand you to say that the interior is the same in the sealed pattern as in the guns that were made before there was a sealed pattern?—What I mean by the interior is the interior surface. The bore is always made to the thousandth of an inch according to pattern, and so is the exterior surface; but the build-up of the gun is not the same in every gun, though they all have the same general features.

563. But take the feature of the lining?—Very few are alike in that respect. It will be seen when I explain the diagrams, that when the lining was put in, it was because there was a defect in some particular part; if it was in the vicinity of the bullet-chamber we did not put the lining throughout the whole gun, or, if it was in the vicinity of the muzzle, we did not put it throughout the whole of the gun. But if there were two or three defects, we should perhaps bore out the whole of the gun.

564. A good many of the Elswick guns were lined in the same manner, were they not?—A good many.

565. Were there as large a proportion of the Elswick guns lined as of the Woolwich guns?—No, I think not; and I will give you the reason. I am very much more rigid with my examination of my own guns than I should be with any other guns; and if I have found any speck whatever, I have generally either condemned the gun altogether, or put a lining through the whole of it.

566. Captain *Jervis.*] Can you give the Committee a drawing of the particular gun that has been sealed?—I have not that particular drawing with me.

567. *Chairman.*] Thus far, you have stated to the Committee, that whereas Colonel Bingham said that he thought nearly half the guns in the service were unserviceable or very faulty, you differ with him, and you consider those guns to be serviceable guns?—To bring our 1863 knowledge and experience and standard to test the guns of 1859 would, I think, not be fair. We do not think very much of those guns now. The guns of 1861 were very much better than the guns of 1859. The gun of 1862 is better than the gun of 1861. And with my present knowledge, I think the guns of last year are very bad in many particulars; but even taking the first gun, with its many defects (and I speak deliberately), I do not know of any breech-loading gun outside the War Department that is yet equal to it. Although it is the worst of all, still it is a very good gun. If I had known that those linings would have been complained of, or if Sir William Armstrong had known it, we should not have lined them; we would have bored them out. They were to be made for 200 *l.* a-piece, and they have been made at 87 *l.*; and now, working that price up to 100 *l.*, I could make them as good as any guns of the kind that were ever made.

568. But still a large number of guns have been issued for the service, and it is the opinion of Colonel Bingham, and I suppose of the authorities he represents at the Horse Guards, that those guns are not serviceable guns; do you agree with him?—I do not consider that they are unserviceable on account of those linings. It is the opinion, I dare say, of Colonel Bingham, and a great many others, especially in the military service, that those guns have failed in consequence of the tubes; but by these drawings I will show you that the tubes had nothing to do with it, and that the tubes have actually saved particular guns; it is not the linings at all, it is the gun itself.

569. But Colonel Bingham having said that he considered a great many of the guns in question were unserviceable, my question to you is, do you agree with him or not?—There are three of the guns which I consider unserviceable in their present condition, but it is not attributable to the linings.

570. Do you recollect the arrangements being made for the experiments that were to be tried at Portsmouth at the end of last year?—Yes.

571. It was considered better to try those experiments with guns selected for the purpose at Woolwich; was it you that selected the guns for those experiments?—No, it was not.

572. Do you happen to know when the Woolwich guns that were sent down to Portsmouth for that trial were made?—They were all made the first year, in 1859-60.

573. Are you aware whether the Elswick Company was furnished with sealed patterns, drawings, and specifications, before they delivered the guns into the store?—In some instances, perhaps, they were, but I think it was oftener the other way.

574. I think the greater number were sent before they received the sealed pattern?—Yes; at all events in the earlier deliveries of any particular guns.

575. Do you know when the sealed pattern was issued to the Elswick Company for the 12-pounders?—I do not know of any other date than the 5th May 1860.

576. Do you know whether the guns made in the Royal Gun Factory passed through the hands of an Inspector of Artillery before they were issued for the service?—Yes, until November last year they did.

577. Then all those guns that Colonel Bingham complained of did pass through the hands of an Inspector of Artillery, and were approved of?—Up to No. 169 gun were approved by him, and after that they were approved by the Royal Gun Factory Department; but still the Inspector of Artillery had the selection of them up to the 11th of November last, and then that responsibility was thrown on the Department.

578. Before that the responsibility was upon the Inspector of Artillery, was it not?—Yes; but with regard to this responsibility I should like to say, that although any one else coming after me may be said to be responsible, I do not wish to exonerate myself from the full responsibility with regard to making those guns as perfect as it was in any one's power to make them.

579. The

579. The Inspector of Artillery at that time was actually responsible for the proof of the guns at the Gun Factory, was he not?—For the first 169 guns he was responsible.

580. And in the case of a gun being found faulty and sent back, was he told of the nature of the repairs made, and did he again know that gun when it was brought before him for proof?—Yes, he knew when that gun came back again; it would depend on whether he had taken the trouble to find out what was done to it, but he knew that it came back to him perfect.

581. Sir *Frederic Smith.*] Was no report sent back with such a gun?—Merely a report that such a number was ready for proof.

582. Captain *Jervis.*] But he did not know whether it was a new gun or a gun that had been found faulty and repaired, did he?—I should think so; but I cannot say.

583. Did he obtain that information from your department?—I cannot say, but I should think he would; he would know the number when he got the gun a second time.

584. Mr. *Baring.*] Does the same number remain on a gun which is altered?—Always the same number; it might be inferred that those guns had been patched up on the sly, but nothing of that kind whatever was done; every gun was the subject of a long study, in order that it might be dealt with in the best possible way to suit its condition.

585. Mr. *Laird.*] Unless you had made a new gun, the number would always identify the gun, would it not?—Yes, the number would always identify the gun; if I had not put in this lining it would have been necessary to bore out the barrel of the gun, and put in a new barrel.

586. Sir *Frederic Smith.*] In the event of your cancelling a gun, would you put in its place the number of the cancelled gun, or a fresh number?—At that time probably the original number.

587. Then the officer would not know whether he got the old gun back or a new gun; he might not know that it was a gun patched up?—No.

588. Major *O'Reilly.*] But the officer would know it was a gun which had been either repaired or substituted?—Yes.

589. General *Peel.*] I see in the Appendix on the Evidence taken before this Committee last year a return of yours, dated the 5th of September 1862; it says, "Return showing the number and nature of Armstrong guns made in the Royal Gun Factory's Department which have entirely failed at proof;" the return states that there were none that entirely failed at proof, but that "several guns were found to be defective at proof, but the defects being of a trifling character, the guns were repaired and then became serviceable"?—Yes.

590. Are those guns now referred to?—Yes.

591. What was the proof on which they were found to be partially defective?—The ordinary proof of seven rounds; two of them with double charges of powder.

592. What were the defects which appeared upon that proof?—When we speak of such defects, we mean defects that were very trifling indeed, little specks that one might require a microscope to see. In one of those very guns that you speak of you would have required a microscope to see it.

593. You said that the guns were proved by the Inspector of Artillery; what was the date of the appointment of Inspector of Artillery?—I have not got the date, but he was appointed before the gun factory had the guns ready for proof.

594. *Chairman.*] Before there were any Armstrong guns ready for proof?—Yes.

595. General *Peel.*] You said that you considered the guns made in 1859 at the gun factory, and also those made at Elswick, were inferior to the guns now being made; in fact, there have been great improvements in the construction?—Yes, very great.

596. But the guns made in 1859 were exactly of the same pattern as the gun that had been approved by the Ordnance Committee?—Yes, exactly.

597. That gun which had been fired 1,200 or 1,500 times was exactly the same pattern as the gun you made in 1859?—Exactly.

598. And you continued that construction until you made the improvement?—Yes.

599. *Chairman.*] You stated that a good many of the guns made by the Elswick Company passed through your hands?—Yes.

600. Have you ever discovered any defects in those Elswick guns that had passed the Inspector of Artillery?—The defects are very seldom of that nature that would make the gun much worse.

601. But let me again ask if you have ever discovered any defects in the guns made at Elswick that had passed the Inspector of Artillery?—I have seen many defects that I would not myself pass.

602. After they had passed the Inspector of Artillery?—Yes.

603. Will you specify the nature of those defects?—They were only small hollows in the gun where there had been little blisters in the iron, which were revealed by the proof.

604. You would not have passed those defects in your own guns, you say?—No, I would not.

605. And they had been passed by the Inspector of Artillery?—Yes; I do not say that they would have interfered with the gun, as a gun, in any way; but still I would not have passed them.

606. Will you put in a return showing the number of the Royal Gun Factory guns and Elswick guns respectively, which have been made and issued for service?—I have made in the Royal Gun Factory very nearly 2,500 guns (within five or six).

607. How many have been issued for service out of those guns?—I do not know exactly how many have been issued for service, but there have been very few complaints, and those three that are said to be unserviceable are perhaps about the worst of all.

608. Will you specify, in detail, as far as you can, the nature of the defects of those Elswick guns which you say had passed the Inspector of Artillery, and in which you found out defects which he did not find out?—They are all of one kind: small holes in the interior surface of the gun; they are not very large, but still they are there. I have the numbers of a great many of them in which this defect exists.

609. Defects that the independent inspection had not discovered, but which you did discover?—They did discover them, but did not think they were bad enough to induce the rejection of the gun.

610. Had they anything to say to this question of lining?—I should suppose they had. I did not disguise

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disguise any thing from them in any way. I always said, "I would line that gun," and I should suppose the same thing happened with the Elswick guns. I had to line some of the Elswick guns for the Inspector of Artillery, so that he must have known of them.

611. Mr. *Laird.*] Was Sir William Armstrong aware that you were lining the guns?—We always studied this question with immense care.

612. It was done with his full consent and approval?—Yes, with his full consent, and with my full approval also, though I would not have done it with my present knowledge now that it is objected to; but still, if I had had to pay for those guns, I would certainly have bouched them.

613. *Chairman.*] Will you give the Committee the history of the guns which have been returned?—Those three guns that have been so much complained of are Shorncliffe and Portsmouth guns. These guns have been fired a great deal. There are 14 returned altogether; the three worst I have already explained; 11 of those had other defects, in some a very small portion of the screw broken, and in many of them it is just cracked at the extremity, though it is very little; of course that could be improved by another arrangement, as it is in some of the lighter guns. In one of the 11 the lining has shifted about one-tenth of an inch.

614. But can you state how many field guns have been subjected to the same usage that those 14 guns have been subjected to; how many have been fired so rapidly, and so often?—I have no means of getting that information.

615. But do you know whether it was not in consequence of a certain number of the guns (without having been exposed to very rapid firing) having shown certain indications of failure, that His Royal Highness the Commander in Chief directed those experiments to be tried at Shorncliffe and Portsmouth?—If the guns were at all good guns, I do not think that, but I have no information upon the point, because I have only seen the guns after they were returned to Woolwich as unserviceable.

616. You have said that there have been great improvements in ordnance since 1859; do the guns now made vary from the sealed pattern and from the original patent, which must have described the construction?—There have been none of those guns made since then. This is the land service 12-pounder, the other is the naval service 12-pounder, and it is a different gun.

617. They are not according to the patent, or the sealed pattern of 1859?—I do not know about the patent, but the sealed pattern is different; it is shorter.

618. But as to the principles of manufacture; are the guns manufactured on the same principle as those of 1859?—Very nearly.

619. There is no difference in principle, is there?—I cannot think of anything at this moment as to which I can say that there is a difference in principle.

620. *Chairman.*] Will you now proceed with the description of your diagrams?—This dark blue line represents a section of the tube put into this particular gun, No. 198 (*see* Plate A), which is one of the worst of the three that have come back. The diameter of the copper bouch determines the size of the tube; we could not make it larger, because the screw had to interchange in all the guns, and it was impossible to get in a thick tube which would take a copper bouch. Now, in those guns the whole of the interior was made by coiling up the iron in the ordinary way of Sir William Armstrong, and this portion *a* is joined to the other portion *b* in the sound gun; but in this particular 12-pounder gun it has broken at this place, and is gradually drawing out, the bouch, however, remaining perfect; it is torn out about half an inch at one end, and about the tenth of an inch at the other; but there is one thing which I will call your attention to, namely, that there have been no accidents whatever with any of those guns, and none even with this particular gun; it has been fired a considerable number of times after it began to break up, so that that shows the amount of safety which exists in guns of this character.

621. Sir *Frederic Smith.*] Do those black marks which you have made on the drawing indicate the separation which has taken place?—Yes.

622. It amounts, does it not, to seven-eighths of an inch?—About three-quarters of an inch.

623. Is that filled up in any way?—No; it is left just as it came.

624. Major *O'Reilly.*] Are you sure that the lining shows no crack?—Quite sure.

625. You can see that, can you?—Yes.

626. Sir *Frederic Smith.*] How many times has that gun been fired since the injury appeared?—I do not know.

627. Sir *Morton Peto.*] Had that gun been subjected to any severe charge of powder?—In the first instance, it had two rounds fired with a double charge and then 10 rounds with a charge of about $1\frac{3}{4}$ lbs. of powder, the service charge being $1\frac{1}{2}$ lbs.

628. But you have no reason to suppose that that gun has been subjected to any severe test, have you?—No; I suppose that it had been imperfect in the first instance. When we began to manufacture we used a very strong sort of iron, and the strength of the weld in that quality of iron is never so good as when the iron has less carbon in it. In a softer and thicker iron we get as much as 14 tons tenacity per square inch; with iron of this quality, the tenacity is only about 10 tons to the square inch.

629. Mr. *Baring.*] Was this one of the three guns that were returned to you?—Yes, and the tube of the gun is perfect.

630. Was it one of the guns which was described by Colonel Bingham as having been patched?—I suppose so.

631. And the word patching you believe him to have applied to that lining of the barrel of which you have spoken?—Yes.

632. And you now believe yourself to have proved by that diagram that the defect of the gun was in no way to be attributed to that lining?—Exactly.

633. Then it would be incorrect to attribute the failure of this gun to what Colonel Bingham called patching?—Certainly.

634. Therefore, no argument can be drawn in consequence of the failure of this particular lined gun with respect to the unserviceable quality of other guns that have been lined?—No such conclusion can be drawn with respect to this particular gun. I have not heard whether any other guns may have failed.

635. This gun has failed in a part to which any ill consequence, if any, from the lining would not apply?—Yes; the gun has been kept from going in two by the bouch.

636. Can

636. Can you state why that particular gun failed where it did?—Yes, I think I can; with all the good qualities of those guns, and with all the good qualities of the original gun, I do not think it is exactly the gun which we should now make, with our present knowledge and experience.

637. Mr. *Dodson.*] When was this particular gun made?—In 1859; this was the first gun.

638. Mr. *Beecroft.*] Do you attribute the defects of the gun entirely to the quality of the iron?—I suppose that in this gun there had been a weld just where the shoulder came, and in guns made with this quality of iron the welds are not very strong.

639. You require a very ductile iron, do you not?—Yes, a very ductile iron; we require iron of a quality a good way from steel, in order to weld kindly and strongly; if there had not been a corner, or if it had been a solid forging, we should have had 22 tons per square inch in every direction; here they could scarcely have been over 10 tons.

640. Sir *Frederic Smith.*] How do you ensure the equal connection between the lining and the original gun?—There was very great pains taken to make a sound job of those guns; we bored the guns out taper, ground the hole out, and pushed the lining with 500 tons of pressure; the idea was, that when the fluid pressure of the gas came it would push the lining against the surface, and not disturb it; and, in fact, I have yet to know that it has been disturbed; I do not see how it can be; I suppose it ought to act like the leather in an hydraulic press.

641. You cannot ascertain, can you, whether there has been any separation, except by breaking the gun up?—No; and we can proceed only by carefully measuring before we put the lining in; I may say that I do not think the gun is so good as one without a bouch.

642. Major *O'Reilly.*] If from the pressure the bouch had moved, would it not show that by projecting, so that a change of measurement would inform you of the fact?—Yes.

643. Fourteen guns are all that you say have been returned to you?—Yes.

644. And 11 were returned from defects in the screw?—Yes, and in one the lining has shifted about one-tenth of an inch.

645. General *Peel.*] Did you say that that was one of the first guns you ever made at all?—Yes, one of the first we ever made at all; in 1859.

646. Mr. *Dodson.*] You do not mean to say that this particular gun is identically the first gun that you ever made, but that it was one of the first lot that you ever made?—Yes, one of the first lot.

647. *Chairman.*] Will you now proceed with your explanations?—This next gun is numbered 287, and you will see that it is a bouched gun. Now, the whole interior of that gun is positively perfect, and there is no cropping out. It is this outer coil which is split along there, at the point *a* in diagram B.

648. Mr. *Beecroft.*] Do you think that that was in consequence of the quality of the iron?—I think not; we shall find when cut into that the breech piece has split, and that the fluid pressure has bulged out the interior surface, so as to act too powerfully on the outer surface, and produce this crack.

649. Colonel *Dunne.*] Do you know if the original theory of Sir William Armstrong was a solid gun, a gun with a lining, or without a lining; I mean the first gun which he introduced?—The first guns which he introduced were all built-up guns.

650. Are you able to say whether the original gun was a gun with a lining, or are you not certain?—I am not certain.

651. You cannot say when the lining was adopted at first, whether it was from the moment the gun was introduced into the service?—No; when the guns began to come back from proof, they were found to have certain defects in them. With cast guns, there seldom were any defects; we then saw that we must either condemn these guns or patch them up to avoid expense. Then we put a lining in. After studying the structure of the gun, we thought we could put a steel lining, or a solid forged lining bored out, and so make a perfect gun.

652. Then that was done to remedy an inconvenience which was found to exist, and to avoid expense?—Yes.

653. Was it done, do you know, by the authority of the Secretary for War, or was it reported to him?—I think not.

654. It was approved by Sir William Armstrong and yourself?—Yes.

655. Was there any form or specification given when the contract was entered into by Sir William Armstrong, or was he left to settle those details himself, do you know?—Those details were left to him, I should suppose.

656. There was a certain number of guns issued without those linings, was there not?—A great many.

657. Are you aware that a great many field guns are now returned and in store on account of this lining having given way?—I know of these three guns, and also of a fourth, No. 190.

658. Are you aware whether it is the fact that the Government have decided that these guns should be withdrawn from the service?—I am not aware.

659. Should you be surprised to hear, if riding in front of a battery, the lining might be seen to hang out?—I have had no opportunity of seeing anything of the kind.

660. Have you heard that report of the intention of changing those guns?—I have not.

661. In answer to Question 1631, last year, you said you considered that the most perfect kind of gun would be a gun with a steel lining?—Yes.

662. Do you still continue to hold that opinion?—Yes, but it is not the kind of lining we have now before us, which I then referred to.

663. Will you oblige the Committee with an explanation of the difference between the two kinds of linings?—Those original guns were made with a wrought-iron barrel.

664. But inside, how were the linings made?—Inside it was coiled wrought-iron, which is very good; but it is not so good longitudinally as it is circumferentially, and hence those guns were all weak at that particular part. Some of those guns were made out of a solid forging, which is not so strong circumferentially as it is longitudinally. I should like to see a perfect steel lining, which, when it is good, is very good, and will give us a tenacity of 35 to 40 tons per inch, but if we had set out with steel instead of wrought-iron, we should long before this have had to give up, for steel is so uncertain that I would

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would not trust it even now for the body of the gun.

665. I understand you to say, then, that at present you prefer wrought-iron for the lining?—I think I would venture on steel, because I could ascertain whether it was good before I put it in.

666. You think it would be more uncertain and more expensive than iron?—Yes.

667. Do you think it would be worth the expense to try guns of that kind?—I would venture upon it guardedly at first, and I would not venture far.

668. Do you know Krupp's guns?—Yes, very well.

669. They are made of homogeneous iron, are they not?—I call it steel.

670. Are they the kind of gun that you approve of?—No; I would not go so far as that; I would not venture nearly so far.

671. Is not there a difference between the exterior and the interior metal to be taken into account?—Yes, but still I would not go so far as that.

672. Mr. *Dodson.*] In what year was the gun made you have been speaking of?—In the year 1859.

673. It was made in the first lot of guns, I understand you to say?—Yes.

674. Made in the same manner as gun No. 198?—Yes, and bouched in the same manner.

675. Mr. *Baring.*] Have you a diagram of the third gun that failed?—Yes; this gun, No. 160 (*referring to the diagram* C.), is quite a different one; the bouch occurs about 14 inches down the gun; the gun is perfect throughout the rest of the bore, but the part that has failed is nowhere in the vicinity of the interior; it is outside, for there is a small portion of the weld which is not sound at the point *a*. Although I have made a thick line in order to show the crack, it must be observed it is not near so large as it is shown here, being, in truth, a very faint line indeed, and it is not at all in the vicinity of the bouch.

676. Mr. *Dodson.*] When was that gun made?—In the same year as the other.

677. Mr. *Baring.*] Therefore you think the bouching of these guns has not had any effect with respect to their failure?—None whatever.

678. Can you state, as a manufacturer, that it is impossible that it should have had any relation to the failure?—Quite so.

679. In the other 11 guns where has the failure been, do you know?—In nearly all the other 11 guns it has been in the screw.

680. And it would be absurd to apply any failure in the screw to the bouching of the guns?—Quite so.

681. It would be ridiculous, would it not?—Yes.

682. Have you had any guns sent back to you in which there has been a failure in the bouching?—Yes, one, No. 190.

683. Not one?—Yes, one.

684. If, therefore, the guns which were said by Colonel Bingham to be unserviceable because they were patched, have failed on account of the bouching, you are not yet aware of the fact?—No.

685. Mr. *Dodson.*] Were the 11 guns, 1859 guns?—Yes, they are all 1859 guns.

686. Mr. *Laird.*] Have you known any instance in which the tube has slipped backwards or forwards?—Except in 190, I have seen nothing of it; some one has said, I believe, that it has been reported to the War Office that there are guns of that kind, but I have had no official paper on the subject, nor do I know of any one who has seen it.

687. Have you made any report to the War Office lately upon the subject of the manufacture of these guns?—Yes.

688. Have you got a copy of that report here?—No, but I can give you from memory the five points of it. When those guns came from Shorncliffe to be repaired, a minute paper was sent to me, requesting me to see if we could not put those guns right in the screw, and apply to them all the recent improvements. That was about a fortnight before Sir William Armstrong resigned. I kept the paper back, with the idea of waiting until I could see Sir William Armstrong, to talk it over, because I knew it would be a disagreeable matter to write about those guns; but before I had met Sir William Armstrong he had resigned; and then I had no alternative but just to write and state what I considered the defects of those guns to be, and I mentioned five reasons why they were defective, which reasons I will give you. I may observe, that guns resemble locomotive engines, they were very inferior in 1829 to what they are in 1863, so the guns of 1859 are inferior to those of the present time. The first point is, that I do not think there is sufficient screw in this gun; it is but five inches, while in the 1861 gun it is seven inches. Now five inches is often breaking, seven inches never breaks. Secondly, I do not like the way in which the breech piece was made; by taking two thin shells and welding them together, and laying them face to face, with a V, into the joint, so that the iron from so much heating is not in perfectly good condition. Latterly, the breech pieces have been made out of a solid piece, so that we get greater strength. Thirdly, I rather think that the muzzle is too long for the strength of the gun; in the vicinity of the trunnion. Then, in the fourth place, this strengthening coil which is put on in front of the trunnion, is too short. Fifthly, I think a solid forging, or steel lining, is better for the interior of the gun than the coil, though Sir William Armstrong does not agree with me upon that point.

689. Does Sir William Armstrong differ from you generally about those five points?—From the circumstance that Sir William Armstrong made a second gun with all those points remedied, I should think he was of the same opinion.

690. This report of yours only applies to the guns of 1859?—Yes.

691. Not to guns which are now being made?—No; they have faults of a different kind.

692. Sir William Armstrong agrees with you with respect to the alterations that have been made to improve the gun?—Yes.

693. Mr. *Beecroft.*] Is there not, in solid wrought iron guns, a greater risk incurred with respect to the uniformity of the iron?—Yes, but there is this to be considered, that if we take and forge the iron into solid lumps, and then elongate it into a tube about three inches larger than the bore, and then bore out all the unsound part, the remainder is very sound, and we obtain a very good shell; in putting the iron together we used to do it by piling the iron vertically into lumps, and then elongating it into the form of a cylinder.

694. Did you crossfile it?—Yes; with the larger guns we piled the great slabs above each other

other and then elongated them, so that the weld should be distributed through the mass, and so that the weld should not be in the line of the gun.

695. And that would tend to make the iron of a uniformly tough kind?—Yes.

696. I suppose you still adopt the filing of the iron in that manner for the purpose of assimilating the structure to the coil principle?—Yes, as much as possible.

697. Captain *Jervis.*] You say that there is now a sealed pattern?—Yes.

698. And you are bound to make the guns in accordance with that sealed pattern?—Yes, outside and inside; but I never understood that we had to conform to it rigidly with respect to the structure of the gun.

699. Suppose a gun is presented to the Ordnance Select Committee manufactured in a particularly distinct manner, and that it stands the proof required, and a sealed pattern is given you, how far have you felt yourself at liberty to deviate from that pattern in the manufacture of the gun?—We have done, from time to time, what we thought best with respect to the structure of the gun, but we are bound to conform to the sealed pattern, as to the outside and inside.

700. In the Appendix to your evidence of last year you gave a return of "25 guns, fitted with bouches of various lengths, &c.," and also, "of repairs to guns found defective at proof, which comprises every kind of repair, not specifically mentioned in any of the foregoing:" now, what is the amount of repair which you are allowed to make to a gun in the course of manufacture, and what point is it necessary to arrive at before you condemn the gun entirely?—I myself do not allow a gun to pass if there is anything the matter with it, and since it was supposed that the bouching was bad, I have never bouched any guns; and invariably, if there is anything the matter with a gun now, I put a new bore in.

701. Do you not think that it is not a question whether bouching is bad or not in the opinion of people who perhaps know very little about it, but what is actually right or actually wrong according to the sealed pattern?—The Royal Artillery and the military altogether are a mighty phalanx that I cannot stand up against, and they say the bouching is bad.

702. Are you aware that at Shorncliffe there was a foot of the bouching fired from the muzzle together with the shot?—I do not know that.

703. But I presume you will accept it as a fact from me?—Certainly.

704. Then do not you think there ought to be some specification, not to be departed from, laid down for such an important implement as an artillery gun?—Some day, perhaps, that may be well; we are altering and amending every day. If you look at the result at Shoeburyness on Tuesday last, you will see the wonderful improvement we have made during the past four years, which we should never have made if we had been tied down to anything; probably we should not have been there on that day.

705. Entirely agreeing with you that it is important that you should be free to carry out various experiments for the purpose of endeavouring to obtain a better gun, is it not also necessary that, in the manufacture of an article for the service, any alteration should be fully tested and sealed before it is made?—Yes; I think that, as a general principle, is quite right.

706. In fact, without that, how could you possibly regulate the system of your own inspection; what rules could an Inspector of Artillery lay down?—If there was an Inspector, he ought to know everything about how a gun was treated.

707. I suppose you mean to say that, supposing a gun showed something wrong at the proof, and was sent back to you, and bouched, you ought to tell the Inspector of Artillery what you had done, and leave it to him to pass the gun or not?—If there was an Inspector of Artillery, that would be the course; but I would not try it on if I thought it was not right and proper.

708. Would not you be putting him in a difficult position if he had to take upon himself the responsibility of knowing exactly what had taken place in the manufacture, when the fact is, that it sometimes happens that it is only after being fired a great many times that a fault is discovered in a gun?—Yes; these guns were fired 10 rounds after they left the proof, and they turned out better than many other guns.

709. Is it the fact that, in bouching those guns, you wished to save money?—Yes, that was the only reason.

710. Otherwise you would have condemned the guns?—No, I would not have condemned the guns, I would have put in new barrels.

711. Do you think that the difference in expense would have made that worth while?—We have to put in new barrels every day.

712. But I mean with regard to putting in a portion instead of the whole?—I would put in the whole.

713. But you do, in fact, frequently put in a portion?—It was done in those guns, but we never do it now.

714. Sir *Frederic Smith.*] What do you mean by a new barrel?—I mean that, instead of bouching a particular part of the gun, we should take out the whole of the interior part, and put it in new.

715. Mr. *Laird.*] You would have left the breech part as it was?—Yes; in those guns, it is not of much consequence, but in the larger guns, that difference is an enormous saving.

716. Captain *Jervis.*] If what you say be correct, is it not the fact that the sealed pattern is more a matter of show than a thing actually to guide you in the details of the manufacture?—Yes, so far.

717. I understand you to say that you feel at liberty to make such alterations as you think are for the benefit of the gun, looking at the question of expending public money?—We make no radical alteration.

718. Sir *John Hay.*] The external appearance of the gun and its internal calibre you keep just the same?—Yes.

719. But you would feel yourself at liberty, I suppose, to alter the position of the hoop, for instance?—No; I would not go so far as that.

720. But you would feel at liberty to alter the mode of the construction of the gun, in some respects?—Yes.

721. *Chairman.*] In fact, you consider that there is no defect in the principle of the Armstrong gun; but I think you stated that with regard to four of the faults you pointed out, Sir William Armstrong agreed with you, but with respect to the fifth he differed from you?—Yes, in that particular gun, but every year the guns have been getting better and better.

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722. Do you consider that there is any defect in the principle of those guns?—No.

723. The details in which you think they might be improved you have already mentioned, with respect to this particular gun; perhaps you will state in what particulars you think the guns might be improved with respect to other calibres?—One thing which I consider wrong in this gun is, that Sir William Armstrong was persuaded, by continual pressure, to make them too light. The 9-pounder old service brass gun weighs 13½ cwt., and this gun, which has to take a 12-pounder shot, and whirl it up to 8,000 revolutions a minute, besides the other work it has to do, is only 8¾ cwt. I think that this gun ought not to be made under 10 cwt., if it is to be sound. In fact, I think there is not metal enough in this gun.

724. Sir *Frederic Smith.*] Has that opinion of yours been reported to the authorities?—No.

725. But still you do hold that opinion very strongly?—Yes.

726. Mr. *Laird.*] You think the guns that are now being made under Sir William Armstrong are not heavy enough?—I have often said myself that I would not make a gun which I was not sure would stand, whoever insisted upon its being made light. I would go and say, "You may take the responsibility if you like," but the fact is, you never hear of any one at the head of these matters coming forward and taking a portion of the blame.

727. In fact, as a practical man, you mean to say you have been making these guns lighter than they ought to be made?—We see that they have stood and do stand. No doubt, lightness is a great thing, but I would recommend the adoption of a heavier gun.

728. Sir *John Hay.*] You think the guns would be more durable in that case?—Yes.

729. Mr. *Laird.*] Have you ever stated your opinion to Sir William Armstrong or to the War Office?—Never in writing, but often to Sir William Armstrong in conversation.

730. *Chairman.*] And he does not agree with you?—When I have mentioned it, he would remark that the authorities insist on light guns.

731. Sir *G. C. Lewis.*] What is the motive for making the gun so light; is it the saving of money, or is it the greater mobility of the gun in the field?—Entirely its mobility in the field. Of course lightness is everything, but still there is a point beyond which I would not go.

732. Sir *Frederic Smith.*] You think that you may sacrifice strength to lightness and do wrong in so doing?—I do.

733. Mr. *Dodson.*] Can you state what would have been the cost of putting a new barrel to the gun into which you put a partial lining?—I dare say a new barrel would cost about 40*l.*, a new lining for the whole length about 3*l.* or 4*l.*, and that the lining of diagram C would cost about 30*s.*

734. Mr. *Beecroft.*] And what was the first cost of the gun?—About 87*l.*

735. Colonel *Dunne.*] Considering that a new barrel would cost 40*l.* while the lining would only cost 3*l.* or 4*l.*, and you being of opinion that there would be no danger in the use of the lining, would you not think it more judicious that all the guns should be repaired in the latter way?—No, I would not do it in that way, now that I know better.

736. *Chairman.*] To resume the question of making guns rather heavier, that bears upon the subject of the endurance of the gun?—Yes.

737. Do you consider that Sir William Armstrong's mode of rifling, or the Whitworth system of mechanic, fit to be that which tests most the endurance of the gun?—I have not had so much experience on that point as to be able to say.

738. But the Committee would be glad to hear your opinion upon the subject, if you do not object to give it?—I have recently made a number of experiments, for the purpose of testing the tendency of different systems of rifling to split the gun, and in a table which I have made out, I have put down the relative tendency of every kind of gun to split. I have not a copy of it here, but the lowest was an oval—that required nearly 7½; the highest was the recent shunt of Sir William Armstrong, which was about 46. The original shunt of Sir William Armstrong is about 26—the Whitworth was about 28; I will hand in the table.

739. Sir *John Hay.*] But with reference to that very question of endurance, let me ask you where the tension occurs when the polygroove system is used with a softer metal?—The gun could not split at all with this kind of projectile, from its softness, (*referring to the diagram.*)

740. Mr. *Beecroft.*] Do you consider that there is not sufficient body of iron in this gun, compared with its length?—Yes, that is my opinion.

741. You think it is particularly weak at the trunnions?—Yes; I should like to see a barrel of greater substance coming right through, and with the breech-piece nearly as thick again, and then one coil on the top of all.

742. Sir *Morton Peto.*] Have you any very large stock of the guns to which you object?—364; but they can be improved very considerably.

743. Do you know what number of guns you have in stock of all kinds?—No; I have made about 2,500, and there are those which were made by the Elswick Company in addition.

744. Do you know how many they are?—No.

745. Mr. *Beecroft.*] Can you state how much the weight of the guns would be increased if your proposal were carried out?—I think that 10 cwt. is as light as the gun ought to be; I would have 9 inches of screw; and instead of seven-eighths of an inch in thickness of barrel, I should prefer a substance of 1·4, a shorter muzzle, and with the breech-piece and trunnion in one forging.

746. You think that would increase the weight of the gun about 2 cwt.?—About 1 cwt. 1 qr. and 14 lbs.

747. Colonel *Dunne.*] Have you ever submitted those suggestions to the Select Committee on Ordnance?—No, it has not gone so far as that; but if there were any new guns to be made I should do so.

748. Have you ever considered the difference between Mr. Whitworth's and Sir William Armstrong's guns, with respect to the system?—I have been mixed up with both a little.

749. Which do you consider the better gun for the service?—As a breech-loader for field service, the Armstrong is the best I have ever seen for a small gun.

750. But, taking the two guns together, do you consider there is any superiority in Mr. Whitworth's which would justify the Government in adopting it instead of Sir William Armstrong's, or any other gun?—I think the leaden projectile of

of Sir William Armstrong would not do for a muzzle-loader.

751. Has Sir William Armstrong made or proposed any alteration, do you know?—I think Sir William has been trying a muzzle-loader.

752. Do you think the polygroove system will answer in the field?—I think so.

753. Do you not think that so many angles would tend to wear out the batteries?—If it had a good lining inside it would not do so. I am quite sure the Armstrong gun would last a long time; but my own idea is, that our present and future course, whatever the past may have been, is, to throw it behind us, taking advantage of the experience now gained, and let bygones be bygones with respect to the manufacture of ordnance.

754. You think that in spite of this long series of experiments, we have not yet come to perfection?—Yes, I think so; we make better guns now than were made six months ago; and even with respect to that magnificent gun of Mr. Lionel Thomas's, there are three points even in it, with which I am now very vexed with myself.

755. Do you think the guns of a smaller calibre are more perfect than guns of a larger calibre?—No; I think we can make a gun of any size now, though I am quite sure in a few years we shall be very much dissatisfied with what we are now doing.

756. You consider the whole system of artillery in rapid progress?—Very rapid progress.

757. Major *O'Reilly.*] I think you say that the best breech-loading field-gun is the breech-loader of Sir William Armstrong?—Yes.

758. But do I understand you, in saying that, to be expressing any opinion as to whether the breech-loader gun is or is not the best for field service?—I think that is more a question for an artillery officer.

759. Mr. *Dodson.*] Do you know if any of the guns that have been used on active service in China have come back?—Yes.

760. Have you seen any of them?—Yes, I saw them, and I have altered them, so as to conform them to the modern gun.

761. Have any of them proved defective in active service?—I think not; I have seen something in the newspapers about their losing the vent-pieces, but I do not know.

762. Did those that you saw show any particular marks of wear?—No.

763. You have only altered them to improve them?—Yes, I have made them like the sealed pattern with regard to the vent-pieces; they will never be exactly the same as the sealed pattern, but they answer the purpose.

764. You do not find that any of them have proved faulty?—No.

765. How many of those guns have you seen?—I forget the precise number that went out; I think 12.

766. Major *O'Reilly.*] Will you now produce a drawing of the sealed pattern?—No, I have not brought the sealed pattern, but it is exactly the same as No. 287.

767. Am I to understand, that in the sealed pattern, as now existing, there is a lining?—Exactly.

768. Exactly like the three guns that were returned to you faulty?—The three guns differ.

769. But it is the same kind of lining?—Yes.

770. Then, if you were to make guns strictly according to the sealed pattern, you could make them with such a lining?—I would not do that.

771. But you *may* do it, according to the sealed pattern?—No, I could not do that.

772. Colonel Bingham stated, on the last day of the meeting of the Committee, that if those guns with a bouched lining had been inspected by an independent officer, they would, as differing from the sealed pattern, not have been passed; but could you have insisted on their being passed as being according to the sealed pattern, or could you not?—That is a thing that could not happen.

773. It is a question of the responsibility of the Inspector, is not it?—He would not have known if I had not told him that they were bouched.

774. Sir *John Hay.*] You look to your responsibility to produce a gun that shall appear like the sealed pattern in calibre and external appearance and weight; but, still further, you look to your own responsibility that it shall be the best gun that you can make, whether according to the sealed pattern or not; and if any point arises which you think superior to the sealed pattern, you consider your responsibility involves the producing of that better gun, whether it is exactly like the sealed pattern or not?—Yes, that is my notion of my duties.

775. Major *O'Reilly.*] But if the Inspector is to ascertain the conformity of the gun with the sealed pattern, would not that conformity be arrived at by a gun that was bouched throughout?—Yes.

776. Captain *Jervis.*] But the sealed pattern which did exist, exists no longer; there is now no sealed pattern?—Yes, there is; but it has a lining.

777. *Chairman.*] You have had a great deal of experience as to many matters made for the War Department by contractors; in dealing with them, the sole question which the Inspector has to settle is, whether the article is conformable to the sealed pattern or not?—Yes; but it is the exterior surface that we should go by.

778. Sir *George C. Lewis.*] Supposing one of those guns which have been repaired had been produced by a contractor, and the question had arisen whether the construction of the gun were in conformity with the sealed pattern, how would that have been decided?—If the contractor had known that the pattern was a lined gun, he would have got it passed, I daresay.

779. *Chairman.*] But in any court of law he could have compelled the Government Inspector to pass it if he produced that article exactly according to the sealed pattern?—Yes, but there was nothing of that kind.

780. Major *O'Reilly.*] You have been asked if the sealed pattern extends to the mode of manufacture as well as to the external and internal appearance of the gun: could the sealed pattern prescribe the mode of construction in all particulars, as for instance, with reference to the mode of laying down the iron and preparing the mass for welding?—No, it would not extend to that.

781. Captain *Jervis.*] But suppose you took a gun and split it in two, you could tell whether it was in accordance with the sealed pattern or not?—Yes.

782. Major *O'Reilly.*] Could you see how the iron had been laid when it was in mass before the gun was made?—Not the solid parts; it is with regard to the piling of the iron before it is welded together.

783. Mr. *Laird.*] You think a contractor could have

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have forced the Government to take a gun with a lining?—Well, the Elswick Company did of course send in some lined guns, just as we do.

784. And they were passed, were they?—Yes.

785. Then suppose guns had been made by a contractor, and there had been a specification and sealed pattern, would there have been any difficulty in detecting any deviation from it?—If they were well done it could not be seen; when the gun was new even the proof would not show that they were bouched; but no one would bouch them unless they were driven to do it.

786. On account of the expense?—Yes.

787. Was there any specification attached to the sealed pattern when it was sent down for you to make the guns by?—I daresay there would have been a signed drawing by Sir William Armstrong.

788. But no specification?—No specification.

789. You have had no specification of Sir William Armstrong's patent?—No.

790. Have you made those guns from the verbal directions of Sir William Armstrong?—We were so well acquainted with the construction before we began, that we did not want many directions.

791. Have you made those guns from time to time according to the direction of Sir William Armstrong?—Yes.

792. And you made the deviation and alterations from time to time according to his instructions?—Yes. I do not say that I do nothing on my own account, but I did nothing without his knowledge.

793. You reported to him if you were going to make any deviation?—Yes. With regard to this lining, we consulted together as to the right way of doing it.

794. Major *O'Reilly.*] With regard to the inspection by the Inspector or Assistant Inspector of Artillery, can you state when the guns are inspected by one or other of those officers?—Yes, I know all about it.

795. You manufacture a gun and you prove it?—Yes.

796. Whom do you deliver it to?—To the Storekeeper.

797. Does he take it into the store without inspection?—Yes.

798. Then, the gun being in the custody of the Storekeeper, when is it inspected by the Inspector or Assistant Inspector of Artillery?—When it is to be selected for issue.

799. And it is so inspected at that time?—Yes; but we are held responsible for it.

800. But is it inspected by an independent artillery officer before the issue?—Yes.

801. Is it the fact that every gun that has been issued has been inspected by an independent artillery officer, namely, an Inspector or an Assistant Inspector before issue?—That applied to every gun up to November last.

802. Sir *Frederic Smith.*] Have you the means of being quite sure of that?—Yes, I have the correspondence.

803. What correspondence do you refer to?—Certain Minute Papers with respect to the mode of inspection. There had been something said about an Inspector of Artillery opening up the Royal Gun Factory guns and taking out the plugs after they were greased, and a question was raised as to whether it was necessary, and seeing that we had done it ourselves; and those papers contain some remarks upon the subject to the effect that this question is now under consideration, and in the meantime guns are to be issued on the responsibility of the Royal Gun Factory. That was in November last.

804. Will you put that correspondence in?—Yes.

805. *Chairman.*] Since November last the Inspector of Artillery has had nothing to say to the guns issued for service, has he?—We furnished him with the history of every gun, its defects, and so on.

806. Does he prove them?—His people prove them.

807. Up to the present time is that the case?—Yes.

808. Captain *Jervis.*] Is that done under your superintendence?—It is just the same as before; there is no change in the individuals, but I am responsible.

809. Mr. *Laird.*] All the guns up to this time are in fact proved?—Yes.

810. Captain *Jervis.*] When did Colonel Tulloh cease inspecting the guns in the Royal Gun Factory?—I do not know the date; there are about 170 guns proved by him.

811. Colonel Tulloh in his evidence last year says that he had been Inspector of Artillery from the 31st December 1859, to the 8th July, 1861; during that time he inspected, you say, 170 guns?—Yes, 169 was the precise number.

812. At that date he ceased having anything to do with your factory?—Yes.

813. And no other artillery officer replaced him?—Not for the Royal Gun Factory guns, but still the guns went to the same individual to prove them even after that.

814. But were not instructions clearly laid down that the responsibility of the proof rested with the Gun Factory and not with the Inspector?—Yes.

815. And therefore they were alone responsible?—Yes.

816. *Chairman.*] But still, whatever instructions may have been given, the fact remains that no gun goes into the hands of the Royal Artillery except a gun that has been proved by the Inspector or Assistant Inspector?—Proved by the Inspector? I do not know; but the gun goes just as contractors' guns go.

817. But that is before it goes into the store?—Yes; then there is no proof after that.

818. But before November last, before going into service, did it not pass through the hands of an Inspector of Artillery?—Yes.

819. And he did subject it to a certain proof?—No, he only examined it.

820. He did not prove it?—No; there were very nearly 300 of the first guns, fired ten "Developing rounds."

821. And every one of those guns complained of by Colonel Bingham was inspected by an Inspector of Artillery?—Yes.

822. And proved by him?—Most of them.

823. And the Inspector of Artillery was Colonel Tulloh?—Up to 169 guns.

824. Were those guns that are complained of amongst the 169?—One of the guns was in that number.

825. Sir *George C. Lewis.*] With regard to the inspection in Colonel Tulloh's department of guns in store previously to their being issued, is it not morally impossible for any man to find a flaw in a gun by an inspection of that kind?—

kind?—Any flaw on the surface he would find out.

826. But he could not find out such a flaw as this, a flaw which would have prevented the gun from being issued to the service?—No.

827. The inspection, then, is no inspection at all, so far as that is concerned?—No.

828. If you had never seen a gun before it went into the store, and were asked if it were fit for service, would you have taken upon yourself the responsibility of answering the question by an inspection of that kind?—No, not by an inspection of that kind.

829. *Chairman.*] But could you by any inspection?—If I had taken sufficient pains to ascertain all its deficiencies, I should ascertain whether it was according to the sealed pattern.

830. Would that be sufficient to satisfy your mind?—That is all that could be found out by looking at the gun. We who see the gun during the manufacture know all about it.

831. But an inspection separately from the manufacture does not give a great deal of information?—It can never be equal to an inspection which includes the manufacture, but it may give confidence to others.

832. Ought it to give confidence to others?—If they knew all it might not.

833. Captain *Jervis.*] Could you give in a return of the number of guns passed by Colonel Tulloh when he was inspector, giving their marks of identity?—Yes.

834. And the number rejected, giving their marks of identity?—Yes.

835. And the dates when any of those rejected guns were passed into the service?—Yes.

836. *Chairman.*] Do you recollect the number of those three guns that you have given us a description of?—Nos. 160, 287, and 198.

837. Mr. *Beecroft.*] Are not the guns tested after being approved of?—Very nearly all the first 300 guns had 10 developing rounds, as they are called; the manufacture was in its infancy, and we wanted to see if they were moderately good before they went away. From the instructions given you could hardly infer who was responsible; but it was to be done by the artillery.

838. But are not the guns always inspected after being proved?—Yes.

839. Captain *Jervis.*] Were those 10 rounds fired for the purpose of proving the gun?—Yes, I suppose so; to see that they were quite sound. I suppose it was to try everything else as well.

840. What do you mean by everything?—The carriages, the guns, and the whole of it?

841. Were those proof charges merely to try the gun itself?—They would try everything.

842. Was it not also to test the fuses and the shells besides?—They did not fire any fuses or shells; they were solid shot.

843. Sir *Frederic Smith.*] What was the charge?—1¾ lb.; just a little over the usual charge.

844. Mr. *Laird.*] They were not then tested in the way laid down by the Ordnance Committee; they did not undergo the same test as a new gun?—No.

845. Captain *Jervis.*] What is the ordinary proof?—The ordinary proof is double the ordinary charge of powder.

846. What was the charge used for those 10 rounds?—1¾ lb.

847. Therefore, that was no test at all as far as a proof charge was concerned?—Yes, it was a good test.

848. If 1½ lb. is the service charge, and double that is the proof charge, do you think that 1¾ lb. can be a good test?—You must remember that it was 10 rounds on the carriages, by the Royal Artillery.

849. Have you not sometimes seen a gun burst with one round at the proof charge after it has stood 1,000 round with the service charge?—That may be.

850. Mr. *Laird.*] Have the guns at Elswick, and also at Woolwich, not been tested according to the regulations; that is to say, with a double service charge?—All guns, up to a very recent period, were proved with a double charge, but that is being reduced now.

851. Have the guns given way with that proof charge?—It is not good for the guns.

852. What do you test them with now?—We have only commenced the new regulations, but by the new arrangement it is to be 1½ instead of the double charge.

853. Sir *John Hay.*] The reason for that charge is, that in the rifled guns the cartridge is so elongated that it throws the shot too far forward, to a weak portion of the bore, and, therefore, it is not so fair a test as it was before, where the chamber was able to contain the whole of the proof charge?—Yes; these guns are light beyond the chambers.

854. Mr. *Baring.*] Could you give in reduced drawings of those three guns for the purpose of illustrating your evidence?—I will do so.

855. Colonel *Dunne.*] Were any of Mr. Whitworth's trial guns altered in the Royal Arsenal, or were they entirely on his own principle?—Mr. Whitworth's brass guns have been made in the Arsenal, and there was a 120-pounder.

856. On the coil principle?—With a solid interior.

857. But what was the outer part of the gun?—That was coils.

858. Captain *Jervis.*] Mr. Whitworth wrote to the papers last year to say that he had not been indebted to the Royal Gun Factory, that that was entirely his own gun, and that you had made no improvement in it, but you made very serious improvements in the plan sent to you, if I understand you rightly?—There was some misapprehension with regard to the gun sent to us; it was all screwed together; but the gun that we made was the same as our own guns, except that it had a solid interior, and the inner extremity closed and not plugged up; there were some very good points about that gun.

859. Colonel *Dunne.*] Did Mr. Whitworth ever object to your alterations?—No; he was quite willing.

860. Was that alteration made from any apprehension about the gun?—I strongly recommended it.

861. But was the alteration made with Mr. Whitworth's consent?—The plan carried out was similar to what we were accustomed to make.

862. Does he continue of the opinion that the gun with screws would be superior to your plan?—I do not know that.

863. Captain *Jervis.*] Mr. Whitworth states that he has only to offer his thanks for the assistance afforded him in the manufacture of the gun, but that it was made from drawings supplied by himself?

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himself?—He must have been under a misapprehension when that was written; because the plan was very different from the one supplied by him. I should think it was a mistake.

864. Sir *John Hay.*] The gun was constructed on the coil principle, was it not?—Yes.

865. *Chairman.*] Is there anything else which you wish to state to the Committee?—No.

Lieutenant Colonel Edward Morier Boxer, called in; and Examined.

Lieut. Col. *E.M. Boxer.*

866. *Chairman.*] In answer to some questions put to Colonel Bingham with respect to whether any just complaint had been made to his knowledge of the quality of the articles supplied by the Royal Gun Factory to artillery officers, he answered at Questions 354, 355, 356, 480 and 483, that certain 10-inch shells had been issued from your department of an improper weight; will you explain the cause of that defect?—When Colonel Bingham made the statement that shells had been issued from my department of an improper weight, he was not aware of all the facts of the case, and I think I shall be able to prove to the satisfaction of the Committee that the shells in question were made in strict accordance with the only authorised drawing and specification, and that the department is in no way to blame for issuing shells that are now considered to be of excessive weight. When I was appointed Superintendent of the Royal Laboratory in 1855, certain contracts had been entered into by the Ordnance Office for the supply of 10-inch common shells; at that time the inspection of shells came under the Inspector of Artillery's branch, and not under the Laboratory, as at the present time. In making those contracts it was necessary for the Inspector of Artillery to issue to the contractors drawings and specifications, and I now hand in the drawings and specifications which were delivered to the contractors to guide them in the manufacture before I had anything to do with the matter. At the present time there are only two natures of 10-inch shells, but there were at that time three descriptions of shells for the 10-inch guns and mortars; one was only for mortar firing; this is the drawing of the mortar shell (*handing in a drawing*), and this is the drawing of the shell which is now stated to be over the authorised weight. By comparing those two drawings, it will be seen that the two shells are identical with regard to thickness of the material and exterior dimensions, and only differ with regard to the fuse holes. There was a third description, termed a "10-inch naval shell or hollow shot for land or sea service." This shell has a different thickness of material, and a different exterior diameter, and a different fuse-hole. It is for the naval service, and is fitted for a metal fuse. It will be seen from the drawings, that there were no limitations with respect to the weight—the only limitation having reference to the thickness of the metal, the exterior diameter, and the eccentricity of the shell. The consequence is, that if a shell is delivered by the contractor, in conformity with the authorized specification, the inspector is bound to pass it, whatever may be its weight. There has never been, to my knowledge, any limitation of weight for shells for smooth-bored guns, or mortars. I may mention, that from 1854 to the end of 1855, nearly 200,000 shells were obtained by contract, in accordance with this specification. Some of them were passed by the Inspector of Artillery, in 1854 and 1855, and the remainder of them (a large number) by myself, as Inspector, and not as a manufacturer, in the latter end of 1855. We have only made, in the department, 1,000 of these 10-inch shells, and they were made in strict accordance with the authorised drawing. In order to show that a difference in weight between the land and sea service 10-inch shells was officially recognised, I will explain shortly what has taken place since it was found that this particular shell was too heavy for the 10-inch gun. In August 1860 the Select Committee wrote to me to ask whether I had any records in my office about limitation of weight, or the average weight rather, of the hollow shot and naval shell for 10-inch guns. I wrote to say that I had no such records, and that I could not find any record in the Inspector of Artillery's department. I was then asked to have a certain number of naval and land service shells weighed. I had 30 of each weighed, and sent a return to the Ordnance Select Committee, showing the weight of each particular shell. I found that the naval shell varied from 77 to 79 lb.; and that the common land service 10-inch shell varied from 84 to 90 lb. The whole of these shells were within the limits of dimensions. Before going any further I may explain what variations in weight could take place in these shells, and still be within the limits of the specification. I assume the two extremes, and suppose that the shells are made of the same metal. I take on the one hand the smallest diameter according to the limit, and the thinnest shell according to the limit, and then, on the other hand, I take the largest diameter and the greatest thickness, and I find, from a calculation, that there might be a variation of 12 lbs. in the land service shell, and a variation of 9 lb. in the sea service shell, and still, although that variation might exist, we should be bound to pass them in accordance with these specifications. After sending this list, I was asked by the Ordnance Select Committee what I considered ought to be the limitation in the weight, and I wrote and said, "The limits in measurement practically govern the variation in weight. The present limits allowed cannot be brought nearer without materially affecting the cost of the shells." In the same month I received a letter which will show that the Ordnance Select Committee were then perfectly aware of a difference between the two shells. They write: "Will you be good enough to state whether you are of opinion that any inconvenience would arise from assimilating the dimensions with regard to thickness of metal of the 10-inch hand and naval shells, so as to obtain a reduction in weight of the land service shell, the difference in the fuse holes will prevent the shells being identical. The 10 inch shells for mortars, will, in the Committee's opinion, not bear any reduction in strength." To this letter I answered by a memorandum, dated the 5th of October 1860, as follows: "In my opinion it is very desirable to assimilate the naval and land service 10-inch shells as regards thickness of metal. I feel sure, moreover, that the naval shell is sufficiently strong for mortars." I therefore

fore went further than the Committee in my recommendation. Nothing further occurred until I was examined before this Committee last Session. The question was then raised, and as we had received orders for a large number of those shells, I wrote to the Director of Ordnance to know whether I was to make them according to the then authorised drawing, or in accordance with the naval shell. This was on the 1st of August 1862. I wrote to the Director of Ordnance as follows: "We have lately received large orders for 10-inch common shells. Are these shells to be made to the pattern of the 10-inch naval, as regards thickness of metal and weight as recommended by me to the Ordnance Select Committee in October 1860, or in accordance with the authorised drawing enclosed. A drawing of the naval shell is also forwarded." To that communication I received the following answer: "Referring to your minute of 1st August, the Secretary of State for War having, by minute dated the 23d August, sanctioned the adoption of the under-mentioned changes to govern future supplies, the same is notified for your information and guidance, namely, the 10-inch land service common shells for guns to be in future made so as to conform, in regard to weight and thickness with the naval 10-inch shells." By which it is perfectly clear, that the Secretary of State was satisfied with what had taken place in the matter.

867. Sir *John Hay.*] Then you will not say the fault is in the specification, I presume?—I do not think there is any fault in the specification. It is a question whether there is any fault at all, I think.

868. Is it not a disadvantage to have so large a difference in the weights of a projectile?—The objections to heavy shells had reference to the recoil of the gun.

869. But if your range or charge has to be varied according to the weights of projectiles varying so greatly, does not that appear to you very objectionable?—Practically, by the system of manufacture as adopted in the Royal Laboratory, we do not get a variation of more than 2 lb.

870. But the land service shell appears to have varied 6 lb.?—Those are contract shells.

871. My questions refer to the passing of those shells into the service, and not at all to the Royal Laboratory; I only ask whether you do not think that a specification for the contractors must have been faulty which allowed so very large a variation as 6 lb.?—I do not think that 6 lb. would make the slightest difference. For the Armstrong 100-pounder the allowable limit is 4 lb.; and if it is found necessary (in order to manufacture moderately cheap) to allow 4 lb., then it would hardly do (unless you are prepared to give a very large price) to reduce the limit of variation for the 10-inch shell (which is a mere casting) below 4 lb. or 5 lb. I think a limit of 4 lb. or 5 lb. is desirable.

872. But in the manufacture in the Royal Laboratory you say that the variation is not more than 2 lb.?—Practically.

873. Then why should not the contractors be bound down to that limit of 2 lbs?—Still there are a number of shells that are over that weight. I do not know what per-centage would be over that limit, the average would be about 2 lbs.

874. Then the contractor is allowed to range over an irregularity of one-twelfth of the weight?—So are we.

875. Do you not think that that is very disadvantageous?—It is a question whether you are prepared to pay a very large price for those shells; if it is found necessary to reduce the limits it could be done, but I do not think, as an artillery officer, that it is of any consequence whatever. I would allow 5 lb. variation in that shell; 4 lb. is allowed in the Armstrong, which is supposed to be very accurate in its flight, and in a rifled gun more accuracy is required than in a round short gun. Looking to accuracy, I do not really think that 5 lb. would make the slightest difference.

876. Are you speaking with regard to range?—In range or accuracy. With regard to the recoil of the carriage, that objection cannot hold good, because I find, upon calculation, that the 100-pounder Armstrong gun recoils very much more violently than those 10-inch guns, with the heaviest shell.

877. Major *O'Reilly.*] You say that the distinction of the variation in weight is due simply to the specification, whether right or not?—Yes, that is due simply to the specification.

878. *Chairman.*] And you were in no way responsible for that?—That specification was handed over to me by the Inspector of Artillery; if I had considered that the shell was too heavy, it would have been my business to have brought it to the notice of the Secretary of State.

879. Sir *John Hay.*] Has the limit of 90 lbs. never been exceeded?—It may have been exceeded according to that specification.

880. Colonel *Dunne.*] The diameter of the shell was not altered, was it?—There is a variation in the diameter as well as in the thickness of the metal.

881. But would not the destruction of the carriage depend quite as much on the increased diameter as the additional weight?—Yes, certainly.

882. On account of the reduction of the windage?—Yes.

883. Which of the two was complained of?—I think it was the weight.

884. You think the destruction of the gun-carriage was not attributable to the reduction of the windage?—No; I think it was attributable to the weight.

885. But of course the reduction of the windage would cause the same effect, would it not?—Yes.

886. *Chairman.*] We come now to Question 344, in answer to which Colonel Bingham said that great complaints had been made of the rockets, while in answer to another question, he said that in 1859 a rocket burst at Aldershot in practice, and killed a sergeant of the Horse Artillery, and that orders were then given that no more rockets were to be fired, as they were not considered safe?—I find it stated in answer to Question 35, "They burst in the tubes, and so I suppose it was from faulty manufacture; up to this date we have not had any satisfactory rockets introduced into the service." If the head of a manufacturing department, either as a manufacturer or as an inspector, is to be responsible for the perfect success of every article issued by him, then under those conditions I am responsible for the failure of that rocket which burst; but I think the Committee must see

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that no manufacturer or inspector can be responsible for the principle of construction of an article, because neither the manufacturer nor the inspector has any control over the principle of construction; it is the business of the Superintendent of the Royal Laboratory, first, as a manufacturer, and secondly, as an inspector, to see first of all that the article is made in strict accordance with the pattern drawing or specification, and also to take care that such a system is carried out as to ensure, as far as practicable, that every precaution is taken against a deviation from the specification; but neither the manufacturer nor the inspector can be held responsible for the principle of construction; now, the failure in those rockets is not due to bad manufacture or to imperfect inspection, but to faulty principle of construction. There has been a good deal of correspondence on this subject; when a defect of this kind is discovered a communication is sent to me for an explanation, and I have always, in cases of this description, afforded the fullest explanation. There have been two or three failures lately of this kind, and up to this moment no blame whatever has been attached to me by the Secretary of State or by others, on account of the bursting of those rockets; it has been acknowledged tacitly, if not in so many words, that the fault of the rocket is a fault of construction, and that the rockets issued from my department have been made as perfect as any rockets, upon the same principle, can be made. Since I discovered the faulty construction of the congreve rocket, I have endeavoured, as an artillery officer (not as manufacturer or inspector), who has studied the subject of rockets a great deal, to do what I can to improve its construction; I have made many experiments in order to see if I could not overcome the defects of construction in the congreve rocket.

887. *Chairman.*] As a matter of fact, up to the present moment you find that there is no rocket in the service which is perfectly satisfactory?—Yes.

888. Mr. *Laird.*] But you are not to blame for that rocket failing, are you?—Not at all, unless I am to blame for the faulty principle of construction.

889. You have not been blamed by the War Office?—No; nor have I been blamed by anybody else.

890. Colonel *Dunne.*] You have made no alteration either in the size or weight on your own authority?—None whatever; I have made no alteration.

891. You have followed the specification, drawing, or pattern?—Yes.

892. In rockets and other things too?—Yes.

893. *Chairman.*] In answer to Question 463, Colonel Bingham stated that he understood that certain projectiles were made a little too large for the gun, and also, at the same time, that the gun was decreased in the bore, the result being that the shot would not enter the bore?—There was a question which arose some time ago about the diameter of the diaphragm shell, but I may state, in the first instance, that no shell has ever been issued from my department of a size larger than that authorised, nor do I believe that any gun has ever been issued with a bore smaller than the authorised diameter. There is, however, some foundation for the report of shells having been made of a diameter slightly beyond what was considered to be the authorised diameter. In 1858 I made a proposal to the Secretary of State for War (which was referred to the Ordnance Select Committee) to improve the diaphragm shell, (which was a shell of my own invention), and I was directed to carry out certain preliminary trials in order to perfect its construction. In those trials I discovered that success depended in a great degree on the amount of windage. I therefore took advantage of the new system of fixing on the wooden bottom, and increased the diameter of the projectile. I took the same gauge which we used with the strap shells, and made shells up to the size of that gauge. Those shells were merely experimental shells, and any objections which might have been made against them would have been considered before they were introduced into the service. I made other alterations besides increasing the diameter, and I had just as much right to make an alteration in diameter as in the interior construction.

894. Then this impression arose from some confusion between the service and the experimental shells?—Yes.

895. Sir *John Hay.*] They were not issued for service?—Never.

896. *Chairman.*] At Questions 525 and 527 you will find this: "Did you ever see the report that Colonel Lefroy and Captain Owen made after their return from Gibraltar and Malta, whither they went to inspect the stores? Yes. —Were there not a great many complaints of the stores there? Yes, a very many complaints. That was owing a good deal to the change in the size or cone of the fuse holes, and there was a great confusion of fuses. If there had been one inspector of stores such as you propose, that never could have happened? I think not."—Are you of the same opinion?—No, this matter had nothing whatever to do with inspection. The fuses and shells at Gibraltar at that time were in a very great state of confusion, but that arose entirely from alterations in pattern which took place in 1855 and 1856. They had at Gibraltar shells of one size of fuse hole, and fuses of another size. In 1857 I drew the attention of the Secretary of State to the unsatisfactory condition of the stores at Gibraltar; and upon my recommendation men were sent to Gibraltar and to various home stations to put things in order. I had reported the state of the case before Colonel Lefroy went to Gibraltar, which I believe was in the summer of 1859, and it was from my department alone that the attention of the Secretary of State was first drawn to the fact.

897. In fact, the improvement originated from your suggestion?—Yes, from my suggestion entirely.

898. In Question 436 there is some reference made to some case of port fires issued from your department having failed?—I have not been able to find any report of failures of port fires; since 1855 there have not been any complaints to my knowledge.

899. Can you state the number of articles that you manufacture in your department per annum, or that you manufacture in a series of years?—I was calculating the other day what number of articles have been manufactured and supplied from my department, from 1855-6 to 1861-2. Taking those seven years, I find the value of the articles to be 3,024,000*l.* The number of some of the principal stores I will state, in order to

to give the Committee some idea of the magnitude of the manufacture and issue. Shells and shot, exclusive of rifle projectiles manufactured and issued, 7,036,652 (that is, case and grape included); metal fuses (exclusive of Armstrong), 1,124,435; wood fuses, 2,220,095; tubes, 11,643,607; filled cannon cartridges, 1,812,990; small arms ball cartridges, 353,659,443; small arms blank cartridges, 71,386,962; percussion caps, 596,321,325.

900. Has any Secretary of State during that period ever found fault with you for defective manufacture on inspection?—No; on the contrary, I have been always led to believe that the Secretary of State was perfectly satisfied with the results. Considering the magnitude of the department, the variety and peculiar construction of the articles manufactured, it is surprising to me that so few complaints are made. [*The Witness handed in three drawings of* 10-*inch shells.* See *Appendix.*]

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Lieutenant Colonel Henry Clerk, called in; and Examined.

901. *Chairman.*] Colonel Bingham has stated in his evidence that there have been certain complaints made against the wheels of carriages made in your department; have you anything to say to the Committee on that subject?—I find that since 1854 we have made 40,000 wheels; and I find in all that time only six letters from artillery officers stating that some of the wheels had worked loose, a thing which happens to all new wheels, because the wood is liable to shrink, especially when, from the pressure of the demand, wood not so perfectly seasoned as it might be, is employed; in those cases they might have been repaired and tightened up in about half a day.

902. Have you received any other complaint with respect to the carriages or waggons made in your department?—The only complaint as to waggons was the old story of the Crimean war, the complaint as to some of the waggons being too light; but they were made by contractors.

903. Not in your department?—No; they were manufactured according to pattern, and they were very good waggons as to material and workmanship.

904. Have you known of any cases of carriages for the Armstrong guns failing?—We had a few cases during the first issue of the field batteries; the guns were taken and proved by what is called a developing proof, before being issued; ten rounds were fired with a 1¾ lb. charge of powder. It was then considered that it would be a good thing to try the carriages at the same time with the guns; the guns were so fired, and we found that with the very severe charge to which they were subjected, a few of the carriages did not stand; but those were carriages which had been converted from the previous smooth-bored gun-carriages, and they have been withdrawn and put on home service.

905. That was simply a question of pattern?—Yes.

906. The carriages were made according to pattern?—Yes, and were subjected to a very severe trial.

907. Were you present at the inspection of those guns by the Inspector of Artillery?—On many occasions I was; and I always had my own artificer there to watch the carriages.

908. Were the guns submitted by the Inspector of Artillery to a proper test?—They fired 10 rounds with 1¾ lb. charge, in addition to the ordinary proof trial.

909. Did you not make, in 1860, a report on the weight of some of the 10-inch shells issued for land service?—Yes, that report originated from me. We had had complaints from Malta, and other garrisons, of the 10-inch gun recoiling and upsetting the carriages; so that I made some experiments at Woolwich, and found them very heavy. I then made a report of the excessive weight, and pointed out the desirability of assimilating the pattern to that of the sea service.

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910. Does any officer inspect the articles manufactured in your department after you have reported that they are ready for the service?—No; I am responsible myself to the Secretary of State solely, and no other artillery officer can come in and inspect what I have done.

911. And how long has that system of things worked satisfactorily?—Since 1803; it was first introduced then; and not only have we never had any complaints, but, on the contrary, we have always had the highest praise for what we have turned out.

912. Sir *John Hay.*] You think there would be no advantage in having an independent inspector over all the departments?—On the contrary, I think there would be the greatest possible disadvantage, because it would destroy my responsibility if another officer came in and inspected my work.

913. You do not think then it would be a good plan to have an independent inspection?—It is impossible for anybody but the person who has watched the manufacture from the beginning to judge of an article properly.

914. Sir *George C. Lewis.*] Do you think it would be any advantage to have an independent inspection of articles furnished by contractors?—Yes, we inspect them all.

915. What is, in your opinion, the advantage of doing that?—We receive nothing from the contractor but what we can inspect after the article is complete, but we do not get gun carriages from contractors, or such articles as we could not inspect after their completion. That has been the objection to going to a contractor for such articles. If an independent officer could inspect a gun carriage, you would not want a Government factory.

916. *Chairman.*] And you think the present system in this respect has worked quite satisfactorily?—Quite; during the Peninsular War, the Crimean War, and the Indian Mutiny.

917. Do you find any difficulty in consequence of not having any superior officer over you to direct you as to which order you are to begin with, when you have a number of orders?—No, none at all. There is the Director of Ordnance, from whom we get our orders, and that direction forms a part of his duties.

918. Sir *George C. Lewis.*] To return to the subject of articles made by contractors, let us take guns; do you think it desirable that the

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guns made at Elswick should be inspected?—They are inspected. There is an Assistant Inspector of Artillery on the spot.

919. Do you think it desirable that the guns made at the Woolwich Gun Factory should be inspected also?—I think an artillery officer should see everything, but I do not see the necessity for a second Artillery Inspector to see that the first has done his duty.

920. And in the late constitution of the Royal Gun Factory there was no artillery officer, was there?—There was no artillery officer in charge of the manufacture, but there was an Inspector of Artillery to inspect the work when finished.

921. Do you think it is desirable that there should be such an inspector?—I think it is impossible that such an officer should make a thorough inspection. I think it desirable that an artillery officer should have a certain control over the manufacture from the beginning.

922. If the superintendent of the Gun Factory were an artillery officer, do you think it would then be desirable that the guns manufactured there should be submitted to an independent inspection?—No, I think not.

923. Then you think that if the guns were made at the Royal Gun Factory under the control of an artillery officer, they ought not to be inspected, but that if they were made by a contractor, they ought to be inspected?—If the person who has charge of the manufacture is an artillery officer, I do not think independent inspection is necessary.

924. Major *O'Reilly.*] The inspection of a great portion of the guns made at Elswick depends, does it not, upon an officer who is present at the manufacture, and not upon an officer who only sees the article after it is completed?—There was an Assistant Inspector at Elswick, whose duty it was to prove the guns there.

925. And also to see them manufactured, was it not?—I cannot speak as to that.

926. Are you aware, with respect to the iron ships made by contractors, that an officer is bound to be present at the manufacture, and that the inspection which is relied upon is not an inspection after the article is finished?—I believe that they have inspectors at the dockyards watching the progress of the ships.

Lunæ, 20° die Aprilis, 1863.

MEMBERS PRESENT:

Mr. Baring.	Captain Jervis.
Mr. Beecroft.	Mr. Laird.
Lord Robert Cecil.	Mr. Monsell.
Mr. Dodson.	Major O'Reilly.
Colonel Dunne.	Sir Frederic Smith.
Sir John Hay.	Mr. Vivian.

THE RIGHT HON. WILLIAM MONSELL, IN THE CHAIR.

Captain HENRY WILLIAM GORDON, C.B., called in; and further Examined.

Capt. *H. W. Gordon*, C.B.
20 April 1863.

927. *Chairman.*] I PUT into your hands the proceedings of a Committee of Artillery officers appointed by the Commander in Chief and the Secretary of State for War, to make certain inquiries with regard to Armstrong guns?—Yes; I have had it.

928. General St. George, Colonel Taylor, and Colonel Bingham, were members of that Committee, and Major Young was secretary?—They were.

929. And you have seen a copy of the correspondence with regard to the firing of 10 rounds from the Armstrong guns in addition to the ordinary proof, before their leaving the Arsenal?—I have.

930. Are you not bound to satisfy yourself that all stores issued by you have been inspected, proved, and passed by the officer charged with that duty by the Secretary of State for War?—I am.

931. Then it is your business to make yourself acquainted with all orders and instructions given in reference to these matters?—It is.

932. Who is the person who actually carries on the proof of the guns?—The proof-master, Mr. McKinley.

933. In whose department is he?—He is attached to the Inspector of Artillery.

934. When the Armstrong guns were first introduced, by whose authority were they passed as fit for service?—By the Inspector of Artillery.

935. Can you produce the form of the certificate given?—I produce a copy of the certificate, that was sent to me, by the War Office, authorising me to receive, into store, certain guns that had passed proof by the Inspector of Artillery. That certificate is to the effect that the guns had been "inspected and proved in the Inspector of Artillery's department during the month of June 1860 for Her Majesty's service;" and guns are enumerated as having been supplied by Elswick and others as having been manufactured in the Royal Gun Factory. That certificate is signed to the effect that "the foregoing Ordnance have been inspected, and those in the receivable column have been proved in the presence of the proofmaster under my superintendence, and are fit for Her Majesty's service." It is signed by Mr. McKinley, the Proof Master, and by Captain Noble, who was the Assistant Inspector of Artillery. (*Paper* B., *Appendix.*)

936. Has that system been carried on up to the present time?—The final proof of guns ceased in April 1861, but the Inspector of Artillery still continued to select the guns, whether made by contract or made in the Royal Gun Factory up to November last year.

937. And did he then give a certificate?—He gave me a memorandum, showing that he had selected the guns, but the final proof having ceased, there was no necessity for the additional certificate.

938. Will you put in copies both of the certificate and also of the memorandum?—I will. (*See* Appendix A. and F.)

939. The final proof having been carried on under the order of the inspector, was it certified to you always that such proof was carried on?—Always, upon a similar certificate to the other, only stronger, stating that the guns had been made in the Royal Gun Factory were tested by the Inspector of Artillery, and were further certified "to have been finally proved, carefully examined after firing, and to be, in every respect, fit for Her Majesty's service."

940. Was the charge at the 10 rounds of the final proof heavier than the service charge?—The service charge was $1\frac{1}{2}$ lb.; the final proof charge was $1\frac{3}{4}$ lb.

941. Colonel *Dunne.*] With what guns?—The 12-pounder Armstrong guns.

942. *Chairman.*] When did the final proof of 10 rounds cease?—In April, 1861.

943. What officer now selects all the guns for issue at Woolwich?—At this time the contract guns are selected by the Inspector of Artillery; those made in the Royal Gun Factory are issued upon the responsibility of the Assistant Superintendent of the Royal Gun Factory.

944. How long has that continued?—Since November last year.

945. Until then what officer selected the guns for issue?—The Inspector of Artillery always.

946. What responsibility was involved in that selection?—That they were in every way fit for Her Majesty's service.

947. Did the Inspector of Artillery know the history of the guns?—The Superintendent of the Royal Gun Factory was ordered to give a history of the guns when applied to.

948. Did that officer select the guns complained of in the report of the Committee; I mean the guns

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guns that failed, a copy of which report you have seen?—He did.

949. Can you confirm that statement by any document?—I can. I can lay before you the selection papers of all the guns if necessary, but I will produce one for a portion of the particular guns which are mentioned in that report as having failed. The inspection note, now before me, is signed by the late Assistant Inspector of Artillery (who, I regret to say, is dead), and is dated the 23d of February 1861. Four of the guns are referred to as having been selected—namely, Nos. 190, 198, 287, and 332. (Appendix G.)

950. Were any of these identical guns finally proved by the Inspector of Artillery?—The most part of them were.

951. In making his selection, how could the Inspector of Artillery be aware of the state of the gun?—The Elswick guns were, of course, entirely under his own supervision, and although he did not see them manufactured, yet he had their history. But with regard to the guns made in the Royal Gun Factory when the guns were delivered from that department, they were supposed to have passed the usual proof, upon which they were all packed ready for service, the bores all closed, and the muzzles and breeches stopped up. On receiving them, the Inspector of Artillery removed the plugs, cleaned out the interiors, and took a record of all the flaws that existed, and furnished me with a memorandum of the examination, showing what flaws there were in the guns, so that the records might be issued with these to the party who would receive them. He must have had some information, and that information, I conclude, he got first of all from the Royal Gun Factory, and then checked it with the flaws he found in the guns.

952. Will you put in some copies of those selection papers?—I will. (*See* Appendix C. and D.)

953. With respect to the injuries received by the guns at Dublin stated to have been caused from the use of some fuzes of an obsolete nature, can you state why proper fuzes were not used?—First, they were not demanded, and in the second place, the pattern of the time fuze is still under the consideration of the Ordnance Select Committee.

954. Do you mean to say that the fuzes which are stated by this report to have caused the failure of those guns are still in use in the service?—They are still in the service, and all over the world.

955. Can you state when the fuzes which are here termed obsolete were supplied into the stores, and who passed them?—Some were delivered only towards the close of last year, just in time to send them to America.

956. Those obsolete fuzes are the fuzes now in use in Canada?—Most certainly.

957. Colonel *Dunne.*] Then why are they called obsolete?—That report states that they caused damage to the guns in Dublin, and the Select Committee have a new fuze under consideration, which, when approved, will replace the fuzes complained of, which will be broken up. It is quite an exception acting in that manner, for, generally speaking, we should go on issuing until the old pattern stores were used up.

958. Mr. *Laird.*] You said that the Ordnance Select Committee had not made up their minds with respect to the new pattern?—Just so.

959. And you continue issuing them?—There has been a provisional order by the War Office, for preparing 30,000 of the new pattern fuzes for issue.

960. Although the pattern is not yet finally approved of?—Yes, it is a question of not having india-rubber over the fuze composition.

961. They have not decided that they are proper fuzes?—They have decided that they are proper fuzes with that sole exception.

962. Sir *Frederic Smith.*] Could not that be decided in a very few days?—That is a matter for the Select Committee.

963. Mr. *Baring.*] When any improvement is made in any article of warlike stores, a change is made in the sealed pattern, is it not?—Yes.

964. And all stores which have been furnished upon a previously sealed pattern are termed obsolete, or might be termed obsolete?—They might be termed so, but they would be issued till they were all used up.

965. If that course were not taken there would be an immense loss to the public from the sale, at a reduced price, of masses of stores which might be serviceable, although improvements had been made?—Yes, an enormous loss.

966. Therefore, except in cases where any particular class of stores would be positively inexpedient to be employed, you use up the old pattern before using or issuing the new?—Yes, we use up the old pattern except in cases where the Commander in Chief, or the Secretary of State for War, decide to the contrary.

967. Those fuzes which you have spoken of, were ordered to be broken up?—Yes, when replaced.

968. They being a class of stores which it is very inexpedient to use?—Very inexpedient.

969. The newest and best pattern is now issued?—It would be; but it would depend entirely on whether the Commander in Chief insisted on the old pattern being used for practice; for instance, it would be a matter entirely for the Commander in Chief and the Secretary of State for War to decide.

970. Mr. *Laird.*] But do you know as a matter of fact that fuzes of the same kind as the fuzes which did the damage in question have been issued again for the service?—They have not since been issued for service, except to the Navy. The experiment at Portsmouth took place in November, and supplies were sent to America in September or towards the end of August.

971. You have not issued any of those fuzes since it was known that they had done that damage in Dublin?—I was not aware they had done damage. We have issued some since to Her Majesty's ships.

972. I understand you to say that after its being known that the fuzes had done the damage they had been issued to the service?—They were certainly issued for service since that, but I was not aware of the report, and there were no other fuzes to issue.

973. There must have been a report made to somebody at the War Office, surely?—The report speaks for itself.

974. Colonel *Dunne.*] Is it not quite necessary that you should issue some fuzes or other?—A shell would be comparatively useless without a fuze.

975. Captain *Jervis.*] Do you know how many rounds have been fired with that fuze?—No, it would be quite impossible to say.

976. A large number, I suppose?—I imagine so.

977. Do you know how many guns have been spoilt

spoilt by those fuzes?—I never heard of any guns being spoilt by them.

978. Do you not think it very likely that they were not considered so bad but that they might be used in the service?—I do not know myself, but the Select Committee have had it under their consideration for a long time.

979. If very few guns had been injured by the fuzes, they might still, perhaps, be used safely, you think?—Yes, but they have now all been condemned.

980. Mr. *Laird.*] Orders have now been given to condemn the fuzes?—Yes.

981. Unless they were bad, they would not be condemned by the Government, I suppose?—No.

982. Captain *Jervis.*] Do you mean that they are condemned only in order that a better pattern may be issued to the service?—No, they are ordered to be broken up when replaced.

983. Major *O'Reilly.*] Can you give the date of the approval of the pattern of the fuze which is now condemned?—On the 13 April 1860.

984. Mr. *Laird.*] Can you lay before the Committee a statement of the number of those fuzes in various parts of the world, which will have to be condemned?—I cannot do that, because I cannot tell how many have been expended.

985. Can you give the number that have been issued?—I can.

986. And the number of those that have been replaced by others, both time and concussion fuzes?—I can.

987. Mr. *Vivian.*] Who invented those fuzes?—They were Sir William Armstrong's invention, and approved by the Select Committee.

988. How long have they been in use in the Service?—Since the beginning.

989. *Chairman.*] Precisely the same fuze as Sir William Armstrong's?—The modifications have been very slight.

990. How many different changes have there been?—In the concussion fuze there have been two changes, and in the time fuze there have been three.

991. Mr. *Vivian.*] Upon each occasion was the stock of fuzes in hand condemned?—No, in neither.

992. *Chairman.*] It is stated by the Committee that the guns which failed, were all Royal Gun Factory guns, have any Elswick guns failed, to your knowledge?—The Elswick Company have only made 77 12-pounders, and the Royal Gun Factory have made over 400. None of the Elswick guns have been issued for our field artillery; of the 77 that were made at Elswick, 31 were sent to India, 8 to Melbourne, 16 are in store, and the others were supplied to ships, some having been cut short to make them better guns for the Navy, and some few were considered objectionable.

993. Have you heard how they have answered in India?—I have heard a report; I do not know how true it is, that three guns at Kirkee in the Bombay Presidency, have failed, but I do not place any dependence on that report.

994. The Committee further state, that the guns were received into the service without passing through the department of the Inspector of Artillery, and that such a blunder could not have occurred in selecting lined guns, if they had passed through that department; how do you reconcile that with the statement, that they had passed the inspection of the Inspector of Artillery?—Four guns are named as having been selected by him, to replace others, and it is said he did not know that they were lined guns at the time; whereas he had the whole examination of them, and could have obtained from the gun factory the examination paper, which would have shown him that the guns were lined.

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995. Will you be so good as to put in one of the examination papers you refer to?—Here is one of the examination papers (*producing a paper*) that would be handed to the Inspector of Artillery, and would show that the gun in question was a lined gun. (*See* Appendix E.)

996. The Committee state also in their Report that the ammunition used at Portsmouth and Shorncliffe was all condemned; can you state why that ammunition was not replaced?—There were no orders to replace it at that time; besides, the ammunition was not wholly condemned. The whole of the cartridges were serviceable.

997. Are you able to state what portions of the ammunition are now obsolete?—The time fuzes and the concussion fuzes are both obsolete. With respect to the shells, it is very difficult to say what are obsolete and what are not obsolete, because a new pattern has since been approved which would have the effect of rendering all the Service shells obsolete. The bursters are obsolete, because they are not long enough for the new pattern fuze. But those bursters will be converted so as to suit the nine-pounder shell.

998. I understand you to say, then, that you cannot state whether all the obsolete ammunition has been ordered to be replaced, because you do not know what is obsolete and what is not?—It is obsolete as far as one brigade is concerned.

999. Will you be so kind as to state to the Committee why you issued obsolete vent pieces, knowing them to be so?—In the first place, six guns were ordered to Portsmouth to replace guns which were said to be lined. No vent pieces were demanded for those guns, and it would have been my duty not to have issued any. But in order to make the guns complete, I issued six vent pieces for the six guns in lieu of 18 vent pieces, which would have been the ordinary number. So far from their being obsolete, the War Office on the 16th of January approved of a strengthened vent-piece, made of wrought-iron, for 20-pounder, 12-pounder, and 6-pounder Armstrong guns. That vent-piece was recommended by the Ordnance Select Committee. I asked if they were to replace the old pattern. In the reply I received I was informed that the steel vent-pieces for the 12-pounder Armstrong guns now in store were to be used up, having a portion of the metal turned off the backs, leaving the original thickness in the centre. In accordance with those instructions, I issued altered vent pieces with those guns, and they are still considered to be Service vent pieces until what remain in store are used up.

1000. I understand you to state, that if it was wrong to issue those vent pieces, the fault rested with the Ordnance Select Committee, and not with you?—I do not know that the Ordnance Select Committee approved of them, but I have stated the instructions which I have received.

1001. From whom did you receive those instructions?—From the War Office.

1002. Upon the recommendation of the Ordnance Select Committee?—I do not know.

1003. Have any steps been taken to replace the guns that have failed?—A demand has been received to replace the guns in the 9th Brigade, but

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but it cannot be carried out until some change in the pattern of the existing gun has been made.

1004. Can you state to the Committee at what stations abroad there is field artillery at this time?—There are six batteries in India, but I do not know that their guns have been issued, except with respect to the Bombay Presidency. There is one in New Zealand; there is one in New Brunswick; there are five in Canada, and there is one in China.

1005. Are the ammunition guns and vent pieces at those batteries of similar construction with those which have lately failed?—They are.

1006. Have demands been made by the Royal Artillery, for guns and ammunition to replace those which are considered obsolete and unserviceable?—I believe the subject is now under consideration, but I cannot positively answer your question.

1007. Can you state to the Committee what sum of money has been paid for the guns and ammunition which are now said to be unfit for the Service, and obsolete?—I could state the sums which have been paid for the guns and the ammunition, but I could not show them to be obsolete, because the question of the shells is still under consideration.

1008. But as far as you are able to do it, will you be so kind as to put in a return, stating separately what has been paid for the guns and ammunition now said to be unfit for service, and obsolete?—Yes, I could state the first cost.

1009. Mr. *Baring.*] Taking a gun or vent-piece which is not issued to the Service, I presume that would be returned to the Royal Gun Factory, and that the material would be used up to advantage in some way?—I believe that no guns, or very few guns, have failed to such a degree as to render them unserviceable; but with respect to vent-pieces or breech-pieces, the Royal Gun Factories do not work them up again.

1010. Mr. *Vivian.*] Is it not the fact, that returns are sent in from each station of the balance of ammunition remaining in hand at certain fixed times?—I cannot say as to all stations.

1011. And are there not periodical statements made to the Government of the balance of ammunition in each ship or station?—I cannot speak with respect to ships. I think that, when his commission is at an end, the gunner has to render an account, but not while his commission lasts. With respect to the stores in charge of this (the Military Store) Department at different stations, there are quarterly accounts received at the War Office.

1012. Sir *John Hay.*] Are you not aware that in the Navy a return is made half-yearly of the ammunition in every ship?—I will of course take that statement from the Honourable Member.

1013. *Chairman.*] At all events, you will be so kind as to get the information in the best way you can, and produce it to the Committee at some future sitting?—I will.

1014. Are you able to form any calculation with respect to what sum of money would be lost to the country by all these different things becoming obsolete and unserviceable?—The change of gun has not been determined upon yet; and until that is done it would be impossible to say what the expense of the alteration would be.

1015. Do you know who it was sealed the sealed pattern of the guns made in the Royal Gun Factory?—The Ordnance Select Committee, the War Office, or rather the Director of Ordnance, and then the Adjutant General of the Royal Artillery.

1016. And are all those three authorities responsible?—I consider so.

1017. Then those three authorities had sealed the pattern of the lined gun, which is now declared by the authority of this Committee to be a gun that should not be issued for the service?—They had.

1018. Captain *Jervis.*] I think you state that those guns which failed, and have been spoken of as patched up, had been inspected by the Inspector of Artillery. Can you give the date of that inspection?—They were selected for issue on the 14th of February 1861, but I cannot give the date of the final proof, or of the first proof, but the Inspector of Artillery would not have been authorised to select guns on the 23d of February unless he had complied with the orders of the Secretary of State for War that the guns should have had 10 final proof rounds fired from them, and that they were in every way fit for the service.

1019. But the Inspector of Artillery had nothing to do with proving the guns at the Gun Factory at that time, had he?—He had, according to his instructions, every thing to do with proving the guns at the Gun Factory.

1020. I have before me, in the Appendix, a letter of yours, dated the 9th of May 1860, in which you say, "I have the honour to request your orders how this service is to be performed, observing, that the Inspector of Artillery has nothing to do with the proving of the guns made in the Royal Gun Factory"?—Exactly; but that was overruled by the Inspector of Artillery still continuing to go on proving them.

1021. That is your statement in the letter I have referred to?—Yes, but the Inspector of Artillery undertook the inspection of those guns, and their selection for issue.

1022. But had he the proving of the guns?—Yes, most certainly, at the beginning, though not subsequently; the whole, or a large portion of the 12-pounder guns were proved, or finally proved, by him.

1023. On the 11th of June you say, "I have the honour to request your orders on the following points. At the final proof last Wednesday of the six guns prepared for issue to the 8th Battery, 8th Brigade, and which had been delivered over to me by the Royal Gun Factories, having been proved by the superintendent with the usual cylinders, a large piece came out of the bore of one of the guns; I would wish to know what course I am to pursue in the matter, the gun in question being in my charge as serviceable, and yet not fit for issue. I conclude that I may call upon the Superintendent of Royal Gun Factories to exchange this gun, and which he is willing to do. The question, however, really is, whether the party first proving the guns should not finally prove them, otherwise there is a divided responsibility." Is it not the fact, that at that time, you still reported that the Inspector of Artillery was not responsible for the inspection of those guns?—He was responsible for the selection of them for issue. They were delivered to me proved; yet, according to one of the documents which I have put in, it is shown that the Inspector of Artillery conducted the first proof, because he signed for it, and it is quite clear that he conducted the second proof, because under the second proof the defects in question were discovered.

1024. I understand

1024. I understand that his duty was to select the guns, but had he also the duty of proving them in the Gun Factory?—Yes; the first copy (viz., B., Appendix) of certificate put in states that he had proved them.

1025. But are you not aware that the Inspector of Artillery had nothing to do with proving the guns in the Gun Factory, that being in consequence of a special order of the late Lord Herbert?—I know that there was a special order of the late Lord Herbert, but the practice was the reverse.

1026. Mr. *Laird.*] Can you give the Committee the number of fuzes that have been issued altogether, of both kinds, and without use?—Yes.

1027. And the number issued for service which are known to have failed?—It would be very difficult to say the number issued for service that are known to have failed; it would be better, perhaps, to say issued for service since the new pattern was introduced, the new pattern being still in suspense.

1028. You stated that there had been failures at Dublin in some of those fuzes, did you not?—No; the Report of the Committee says that.

1029. Do you know the date of that Report?—The 17th of November 1862.

1030. Sir *Frederic Smith.*] When did the knowledge reach you of the failures?—When I saw that Report yesterday.

1031. Mr. *Laird.*] Can you say how many have been issued since that time?—I can state the number issued from Woolwich, but not from out-ports to ships, and will supply a return.

1032. Are the returns of those which are expended in the army and navy made to Woolwich?—No; the army return would be made to the Adjutant General at the Horse Guards.

1033. If there are returns made every half year, and they were got, we could easily ascertain the probable stock left on hand?—Yes, but I do not see how I could get those returns.

1034. If we can get from you the numbers issued, and if we can get the returns from the War Office and the Admiralty, we can ascertain the probable loss up to this time, can we not?—I suppose so.

1035. Now, with regard to the defective guns, can you give the Committee the number made at Woolwich, and the number made at Elswick?—My examination has had reference to the 12-pounder land service guns; I can give the numbers that have been made, but not the numbers that have failed.

1036. Can you give the number of those that were made at Woolwich and those that were made at Elswick, speaking of the defective guns?—I will do so.

1037. You said the shells were obsolete; can you tell how many were issued of the obsolete pattern?—I cannot tell whether the new pattern will supersede the old pattern, but will supply a return as soon as I am able.

1038. The shells are not obsolete then?—The first patterns of the shells are certainly obsolete, but they might be used up for practice.

1039. Captain *Jervis.*] They are not so obsolete but that they might be used now?—Yes, but they are ordered to be exchanged.

1040. Sir *John Hay.*] The obsolete pattern was the pattern used in China and for the Indian service?—Yes.

1041. They are not unserviceable, only the other shell is supposed to be better?—Exactly.

1042. Mr. *Laird.*] But still they are condemned?—The first pattern was condemned.

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1043. Those that were issued were not withdrawn, were they?—One brigade are to have them withdrawn.

1044. What will be done with those that are withdrawn, will they be broken up?—I do not know.

1045. The opinion of the Committee now is, that they are not so fit for service as the others, and they are withdrawing them and issuing new ones?—Yes.

1046. Is it likely that the old ones will be used again?—No, I think not.

1047. If they are useful, why should the Government withdraw them?—That is a matter for the Ordnance Select Committee to consider.

1048. Do you think they would have been withdrawn from the service if they could have been used?—I am certain the Committee would not have recommended their withdrawal if they could have been used.

1049. *Chairman.*] I will use the very words of the report, and ask you, whether it is the material described by this report of which you have been speaking: "The ammunition used at Portsmouth in the experiment was all condemned and recommended to be withdrawn. The use of it, therefore, gave a wrong impression. The vent-pieces, which were used for the experiment by the superintendent of stores, were known to be defective, and were of an obsolete pattern. The Ordnance Select Committee had already recommended they should be withdrawn. It was not surprising then, that one should have blown. The whole of the '*matériel*' used in the experiment at Shorncliffe was obsolete, and no fair deduction can be made from its failure." Now, is all the material described in that paragraph in the hands of the Royal Artillery at this moment all over the world?—It is; but the whole of the ammunition is neither unserviceable nor obsolete; for instance, the cartridges and tubes are perfectly serviceable, and the vent-pieces, which are said to be objectionable, are still ordered to be issued by the Secretary of State, and the gun is undergoing a modification; the pattern of the gun still remains, although the alteration is under consideration.

1050. But guns and ammunition, similar to those described here, are now in the hands of the Royal Artillery at different stations all over the world?—Yes, they are; and in the possession of the Royal Navy.

1051. Mr. *Baring.*] With reference to the experiments made at Dublin, let me ask you to read what the Committee say on page 4 of Appendix, No. 8?—"This practice was carried on most carefully near Dublin, and the result may be considered highly satisfactory as regards the strength and the general efficiency of the guns. The only injuries they sustained were of the most trivial character, being slight indentations in the bores, owing to the failure of the time fuzes, which were of the obsolete pattern;" but, at the same time, I must mention that those are different guns, namely, 9 and not 12-pounders.

1052. Is there anything in the report with respect to the failure of the time fuzes, which had caused the injury to the 12-pounder gun?—It does not say that they did injury to the guns, but that a number of shells burst.

1053. Have you seen anything in the report showing that the time fuzes have caused injury

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to guns except in that trivial instance?—I have not seen anything else; but the failure of the 12-pounder gun is attributed by the Committee to the ammunition generally, not to the time fuzes alone.

1054. Both the construction of the Armstrong gun and the ammunition for the Armstrong gun, including fuzes, have been constantly in a progressive state?—Yes, constantly.

1055. Such alterations and improvements, I apprehend, are almost the necessary consequence of the introduction of the breech-loader gun for the service?—I suppose so.

1056. This is especially the case with respect to the fuzes, is it not?—The fuzes are a manifest improvement.

1057. When a new and improved pattern is issued to the service, I presume no more of the old is manufactured?—No more is manufactured.

1058. The new pattern is supplied to the service as soon as practicable; as soon as the old supplies are used up?—Yes; but if the old pattern is objectionable, the new pattern would come into use at once.

1059. Mr. *Vivian.*] With respect to the two guns of the "J" and "K" batteries, which were experimented upon, did those guns fairly represent the ordinary 12-pounder guns in the service?—I should say so.

1060. You have read that report?—Yes.

1061. Do you consider that every 123 rounds fired by the ordinary guns in use in the service would cause those guns to be destroyed and deteriorated in the way in which these guns were injured?—That is more a matter for an artillery officer than myself.

1062. But in your experience with respect to return stores, have many guns been returned from the ordinary use of the service?—All guns that are found unserviceable come back to Woolwich after firing, but it would not be right to compare cast-iron guns with wrought-iron as to the period of duration.

1063. There have not been many cases of rapid firing of the Armstrong guns, have there?—Under the Select Committee certainly there have been at Shoeburyness, and I believe with satisfactory results, but I do not know; all the rapid firing that I know of is what is mentioned in that report.

1064. Sir *Frederic Smith.*] Have you any personal knowledge of that rapid firing?—None whatever.

1065. Mr. *Laird.*] There is, of course, no certainty of the new kinds of shell and fuse answering till they have been tried?—They have been tested to a considerable extent by the Ordnance Select Committee.

1066. The others were so tested too, I suppose?—Yes.

1067. Then it is a matter of speculation yet whether the new shells will succeed or not?—I imagine they will have to stand the test of service, like others.

1068. With regard to the inspection of guns at Woolwich, by whom did you say they were at first inspected?—Up to November, last year, the guns made in the Gun Factory were always inspected by the Inspector of Artillery.

1069. And yet that was contrary to orders?—It was; since that time they have been all issued upon the responsibility of the Superintendent of the Royal Gun Factory.

1070. Before that time the Superintendent of the Gun Factory was not responsible then?—I should say he was still responsible.

1071. But an officer of artillery inspected the guns, though it was contrary to his orders?—Not contrary to his orders; contrary to an order given by the late Lord Herbert.

1072. Then it was contrary to orders from the War Office?—No; he received a special order that he was to inspect the guns.

1073. Whom did he receive that order from?—From the War Office.

1074. Countermanding Lord Herbert's orders?—I do not think it specially countermanded them; but it told him he was to select the guns and inspect them for issue.

1075. He only obeyed orders then, in inspecting the guns?—Yes.

1076. And they virtually countermanded the previous order?—Virtually.

1077. Captain *Jervis.*] Here is a letter from Sir William Armstrong, on the 16th of June 1860; he writes to the War Office, saying, "The question is, how are the duties of the Inspector of Artillery to be defined? If they do not extend to any articles whatever manufactured in the Arsenal, there might, perhaps, be some inconsistency in assigning to him the superintendence of this final proof; but, for my part, I have no feeling on the subject." Is it not evident that he had an impression that the Inspector of Artillery had nothing to do with anything inspected in the Arsenal?—He had not, with the exception of the guns made in the Royal Gun Factory.

1078. But it is as to the guns that Sir William Armstrong particularly speaks, and he objects, in consequence of that, to General Tulloh carrying on the further proof of 10 rounds per gun?—I do not see the inconsistency; Sir William Armstrong says, "There might, perhaps, be some inconsistency in assigning to the Inspector of Artillery the superintendence of this final proof." But he says that he does not care about it.

1079. But he distinctly says that the first proof is in his own hands, and that, therefore, there is an inconsistency in the Inspector of Artillery's carrying on a further proof?—I can only refer to the paper which I have already put in, which is for the month of June 1860, which shows that the Inspector of Artillery proved the guns. (Appendix B.)

1080. But at that very date the Inspector of Artillery is not recognised as the person actually responsible?—Sir William Armstrong says so, but he was not much in the Arsenal.

1081. But the whole of the correspondence is directed to that one point, of the carrying on of that proof?—But still General Tulloh did carry it on.

1082. Now with respect to those shells which were condemned; has that not something to do with the coating?—In the first pattern the lead only came up to an inch and three-quarters of the top of the shell; but in all of the more recent shells it comes up to within an inch and one-eighth, and there are small segments at the top.

1083. But with respect to the pattern you call obsolete, is it not the object to see whether the shells can be re-coated properly?—No, I think not.

1084. You have not heard anything to the contrary, however?—No.

1085. Colonel *Dunne.*] Could you put in a copy of the order from Lord Herbert, desiring the Inspector of Artillery not to inspect the guns?—I think

I think it was previously asked for. I could not put it in.

1086. Then was the countermanding order from the War Office, or from the Commander in Chief?—From the War Office.

1087. Now with regard to the proofs; you say that the service charge is 1½ lb., is that for a 12-pounder?—Yes.

1088. And the proof charge is 1¾ lb.?—No; the final proof rounds were 1¾ lb., but the proof for the gun is 3 lbs..

1089. What shot do you use?—Twelve-pound shot, but the present system has been modified.

1090. Are you aware whether the same system of proof is applied to all guns proposed to be introduced into the service, or whether this is a special proof for the Armstrong gun?—That final proof was for that particular gun.

1091. Suppose Mr. Whitworth introduced a gun, what would be the proof that would be applied?—It is laid down by the Ordnance Select Committee. Capt. *H. W. Gordon*, C.B. 20 April 1863.

1092. Could a copy of that be obtained?—Yes.

1093. Do you recollect the old proof of the ordinary gun?—No.

1094. But there is a special proof laid down for the Armstrong gun, and a new series of proofs for other guns?—There is a special proof laid down for rifled guns, which would include any other guns.

1095. Not unless they are breech-loaders, I suppose?—Yes, for all rifled guns, muzzle as well as breech-loading.

1096. Is the same proof applied to them as to the breech-loaders?—That is a matter for the Ordnance Select Committee, but I imagine it would be different.

1097. But you are not sure?—No.

1098. There is no table by which you could know that?—No. (*The witness handed in Papers* A, B, C, D, E, F, and G. Vide *Appendix*.)

JOSEPH WHITWORTH, Esq., called in; and Examined.

1099. *Chairman.*] Is there any observation which you wish to make to the Committee before I proceed to ask you any questions?—Yes. Before proceeding to give evidence, I should be glad to offer an explanation with regard to the Report made by the Ordnance Select Committee which has, I understand, been furnished by the War Office to this Committee, and now forms part of the evidence before it. As that Report contains an attack upon my personal honour, I have drawn up a statement with regard to it which, with the leave of this Committee, I should wish to read. Since I received the summons of this honourable Committee to give evidence here, it has come quite accidentally to my knowledge, that in November last the Ordnance Select Committee sent in a Report to the Secretary of State for War, in which they state that they had been instructed to report whether the assertions, recently put forward by Mr. Whitworth, in the "Times" newspaper, relative to the construction of his 7-inch gun, are borne out by the facts of the case. From the correspondence it appears that those instructions were, in fact, given in those very words to the Ordnance Select Committee, at the request of Sir William Armstrong, made by him in a letter to the War Office, dated the 1st of December 1862. The Ordnance Select Committee appear to have acted upon those instructions in this way. They applied to the authorities at Woolwich for copies of the correspondence, and they also obtained from some other quarters further information, for, as will be seen, they were not satisfied with confining their report to a personal attack upon my honour, but they took that opportunity to call in question the originality of my system of rifling, and to comment with an animus that is apparent upon other matters not within the scope of their instructions. The Ordnance Select Committee, while they applied to other quarters for information, made no application to me for any explanations whatever before they drew up their report, condemning me unheard. December 11, I came up to London, and put myself into communication with the Director of Ordnance, and also conferred with Mr. Anderson with reference to the manufacture of the 7-inch gun at Woolwich. A drawing of the gun, showing the dimensions and outlines proposed by me, the mode of distributing the metal, and the details of construction recommended, was sent by me to Mr. Anderson at Woolwich, on the 16th of December (*producing a drawing.*) This is a copy of the original drawing which I had prepared for the 7-inch gun. The lower drawing is the gun as now made. *J. Whitworth*, Esq.

1100. Will you put in that drawing?—Yes.

1101. Captain *Jervis.*] Does that drawing differ from the one put in by Mr. Anderson?—This lower drawing is the drawing of the gun as it is now made; the two drawings which Mr. Anderson prepared are these (*pointing to two other drawings*).

1102. Were those drawings that Mr. Anderson put in, correct or incorrect drawings?—The first drawing is my original drawing, showing the screw joints, and the other drawing is the gun as it is now made. After Mr. Anderson had received my original drawing, he sent down to Manchester two drawings for us to see, the main difference being in the breech; and this is another modification of it. Mr. Hulse, my partner, went to Woolwich to consult with Mr. Anderson, and the result of their consultation was this lower drawing.

Acting upon the manifestly one-sided information furnished to them, it must be assumed that the Ordnance Select Committee based their decisions upon the correspondence they have set out. If so, I am prepared to show that while part of the correspondence, and some of the drawings, are set out with the Committee's Report, a most important part of the correspondence, and certain original drawings explanatory of the whole transaction, are altogether omitted. I refer particularly to the letter wherein Mr. Anderson acknowledges that the drawings of the guns he sent from Woolwich, "are made according to the outlines of your (that is, my original) drawing." I am at a loss to understand why that letter, which was the commencement of the correspondence, and the key, as it were, to the whole, was omitted. Again, an article copied from the "London Review" was appended to the Ordnance Select Committee's Report. But if they thought it right to insert that article, to which no reference was made in their instructions, they ought also, in fairness, to have added my reply to it, given in the same periodical.

To enable this matter to be clearly understood, I will,

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I will, with your permission, give a short statement of the facts and correspondence as they actually occurred. December 7, 1861, Sir G. C. Lewis, by a letter signed "B. Hawes," informed me "that he sanctioned the manufacture at Woolwich of a 7-inch gun, to be made accordinn to my principle and under my directions." The gun as proposed by me was constructed in the same way as the smaller 5½-inch guns were made in my works in Manchester. It was, however, always intended by me that the details of construction were to be such as could be most conveniently made by Mr. Anderson. I was satisfied to leave the details to Mr. Anderson, when the dimensions, outlines, and distribution of the metal had been determined upon. In these respects the 7-inch gun proposed by me differed materially from the 7-inch guns made on Sir W. Armstrong's plan; and this is evident, when it is considered that I proposed to make my 7-inch gun weigh seven tons, while the Armstrong 7-inch gun only weighs four tons. December 19, Mr. Anderson wrote to me acknowledging the receipt of my original drawing, and sending two drawings, 68-W., 69-W. (*producing the drawings*), showing a gun finished, as he says, "according to the outlines of your (that is my) drawing, but constructed according to a simpler arrangement of the coils, and one which I would recommend for your consideration," &c. I gave Mr. Anderson's drawings my consideration, and, as the outlines and dimensions I had settled were in no material respect departed from, I looked upon them as mere modifications of my original plan. While I fully appreciated the value of Mr. Anderson's assistance, I considered that his drawings, 68-W., 69-W., were in some respects objectionable. The distribution of the metal, I thought, might be better provided for, by adhering more closely to my original drawing. I also thought that the construction to be adopted would be best settled by a personal conference with Mr. Anderson; and as my health at that time was not good, I arranged that my partner, Mr. Hulse, should go to Woolwich and explain to Mr. Anderson my views as to his proposed modifications of my plan as shown in his drawings. December 21, my firm wrote to Mr. Anderson acknowledging the receipt of those drawings, 68-W., 69-W. The Committee will perceive that that additional hoop was added to this gun (*referring to the drawing*), and then the similarity of the two would be more apparent. In the one gun there is one screw with a close breech, as suggested by Mr. Anderson; whereas in my original drawing it will be seen that I should have liked to have the three screws on one stem. Mr. Hulse sketched in pencil the additional hoop that was employed. Mr. Anderson's suggestion of closing the breech end of the inner tube was adopted, and also the plan of welding the hoops and shrinking them on the inner tube, which was bored out of the solid, as in my original drawings. As the gun was to be made at Woolwich, the preparation of the drawings of the gun as so settled in conference was left to Mr. Anderson. December 24, Mr. Anderson wrote to the Whitworth Ordnance Company, saying, Mr. Anderson, with reference to his promise to Mr. Hulse, begs to forward a tracing, 82-W., showing an amended build of muzzle-loading gun. In this drawing the former outlines are still adhered to, but a hoop is added, which I have just pointed out. December 26, the Whitworth Ordnance Company wrote, acknowledging receipt of tracing 82-W., saying, we will avail ourselves of your offer to undertake the responsibility, and to leave the details of construction entirely to yourself (Mr. Anderson), concluding however with suggestions of certain alterations proposed as to the added hoop. December 31st, Mr. Anderson wrote to the Manchester Ordnance Company: With reference to your letter of the 21st December, I enclose a tracing 87-W., showing the 7-inch muzzle-loading gun, slightly altered in the exterior diameter at the breech. This drawing, being the plan of construction finally settled, and embodying the suggestions made by Mr. Hulse in conference at Woolwich, was considered by me to be the best plan which, under the circumstances of the gun being made at Woolwich, could be adopted. It was a modification of my first drawing, founded upon those sent by Mr. Anderson, which drawings were stated by him to be "finished to the outlines of my own drawing," and it provided for the amount of metal (seven tons) being employed, which I had always insisted upon as being necessary. This drawing showed a gun which, in the inside and on the outside, and in the distribution of the metal, differed in no material respect from the drawing originally supplied by me, and as the changes in detail had from time to time been referred to and advised upon by me, I considered I was making a correct assertion when I stated in my letter to the "Times" that my 7-inch gun was made "according to drawings supplied by myself." The members of the Ordnance Select Committee who, under these circumstances, have thought fit to charge me with making assertions that are the reverse of truth, would, with equal justice, charge every engineer with falsehood who would call a drawing his own, which had, in fact, been made by his draughtsman and embodied any suggestion of detail not made by himself. Every practical engineer will admit that it is quite usual to give general instructions to carry out an intended plan, leaving details to be filled in, and that even, in such a case, he who gave the general instructions would be entitled to consider as his own the drawings which carried out his instructions, though the details were supplied by some one else.

Having, as I believe, answered the personal charge made against me by the Ordnance Select Committee, I may be permitted to say a few words as to the Committee's remarks upon the hexagonal system of rifling, which are as follow: They say, "The Committee possess an hexagonally-bored rifle, dated Enfield, 1843. The more modern and perfect developement of the system is known to have originated with the late Mr. Brunel." In reply to this assertion of the Ordnance Select Committee, I beg to make a statement of the actual facts based on information supplied by Mr. Westley Richards, who acted for Mr. Brunel in the matter. Mr. Westley Richards states, that in 1852 he was requested by Mr. Brunel to make for him a rifle with an octagonal bore, but with an increasing pitch. The rifle was made eventually, and sent to Mr. Brunel on 31st May 1854. That rifle Mr. Richards afterwards borrowed from Mr. Brunel, and some time in 1855 (the date is not known—I think it was late in the spring) he brought it down to Manchester, and showed it to me there. It was rifled with an octagonal bore, sharp at the corners, and had an increasing pitch, beginning

beginning at 1 in 90, and ending, I believe, at about 1 in 30 or 35. That this rifle differs from mine is evident, but there is this fact to be noted besides, that my system of rifling was patented the year before, on 1st December 1854. I should add, that Mr. Westley Richards has taken a license from me under that patent, and before doing so he applied to the late Mr. Brunel to see if he objected to his doing so. Mr. Brunel, in a letter dated 26th November 1858, while he claims having given directions for his octagon rifle to be made, sanctions Mr. Westley Richards taking a license from me. Mr. Brunel says in his letter, "I begin to think there must be something in the principle which I intended to introduce into it, and which is totally different from what I understood to be Whitworth's. I sought to use a comparatively loose ball, but which, I thought, would centre itself, both in position and direction, to the axis of the barrel by the peculiar action of a polygon within a polygon, acted upon by an increasing pitch, and it really seems from the results as if my theory was correct." It is known that Mr. Brunel took no further part in developing the polygonal system than what is here stated, and it is difficult to see how the Ordnance Select Committee can support their assertion, "that the more modern and perfect development of the system originated with Mr. Brunel." Under the circumstances of this report being at this time in evidence before this Committee, I place myself in their hands, and would ask how any evidence given by me can be of weight as long as that report is allowed to remain. Mr. Hulse, my partner, is here, if the Committee should wish to examine him.

1103. *Chairman.*] Do I correctly gather from your statement that you were not aware of the existence of this report till you happened to see the printed papers now before me?—I was not aware before that such a report was in existence.

1104. Did you receive no notification of the Committee having been appointed?—None whatever.

1105. Did neither Colonel St. George, nor Colonel Lefroy, nor any other officer, inform you before they proceeded to adjudicate upon the question?—No.

1106. You never heard of the Committee being appointed?—I never heard of the Committee being requested to report.

1107. The Committee that made the report now under consideration was the Ordnance Committee?—Yes.

1108. Did that Committee, without making any communication to you, proceed to investigate your character?—Yes.

1109. And did they, without letting you know anything about what they were doing, impugn your veracity, and state that it was difficult to suppose that your statements were made through inadvertence?—Yes.

1110. Did I understand you to say that you, or somebody on your part, had written a reply to the extracts from the "London Review," dated 15th November 1862, which are quoted in the report of the Committee?—Yes, we wrote a reply to that statement; I think it was about a fortnight afterwards.

1111. Was your reply inserted in the "London Review" before the 1st December, the day upon which this Committee issued their report?—The date of the reply is the 27th of November, I believe.

1112. Mr. *Dodson.*] The date of your reply was the 27th of November, but on what day did the "London Review" appear containing that reply?—The date of the letter is 27th November; the date of the "London Review" is the 6th of December.

1113. *Chairman.*] Then the Committee quoted the article against you without waiting for your answer?—Yes.

1114. Captain *Jervis.*] But was there not a letter written a week before on the same subject, in the same "Review," from your firm?—There was a short letter a week before.

1115. *Chairman.*] Is this the Committee to which you have expressed your objections to refer decisions with regard to questions in controversy between you and other inventors?—Yes, it is the same Committee.

1116. Sir *John Hay.*] And yet it is the only recognised authority of the Government on these matters?—I believe it is the recognised authority.

1117. Mr. *Vivian.*] You received no request from the Committee to furnish them with a statement of your grounds for making the assertion in your letter of the 11th of October in "The Times"?—I had no communication whatever from the Ordnance Committee on the subject.

1118. Mr. *Dodson.*] When did you first see this report of the Committee?—I heard of it about a fortnight ago, but I did not see it.

1119. When did you first see it?—I did not see it till within these few days.

1120. Until it had been in print, and had been produced before this Committee, you had not heard of it?—No.

1121. Mr. *Beecroft.*] That was the first time you had heard of it?—Yes.

1122. Sir *Frederic Smith.*] Are you of opinion still that the letter you wrote to "The Times" was founded in fact?—Certainly.

1123. You are not disposed to vary from the opinion expressed in that letter?—Not at all.

1124. You adhere to that statement?—Yes, I adhere to that statement.

1125. Mr. *Laird.*] I think you said, that though you might have made out a design, you might yet leave it to another person to decide exactly how the work was to be carried out?—I should leave it to him, if he was a competent person, to carry out the details.

1126. Then he would submit it to you, with the alterations, and it would still be your own design?—Yes.

1127. Sir *Frederic Smith.*] You laying down the general principles, and leaving the details to the other person?—Yes, certainly. The great difference between the gun made at Woolwich and mine, was the difference of weight. [*Mr Whitworth produced two models in boxwood*].

1128. Would it be inconvenient to lay down upon your drawing, in red ink, the alterations made by Mr. Anderson?—I can do that; but the lines will almost come one into another.

1129. Mr. *Vivian.*] And will it be convenient also to lay down upon the same scale a drawing of the gun which was in common use in the service before your gun was made, laying the two guns down in different colours?—Yes. This is a model of the 7-inch bore gun *(pointing to the same)* as they have been in the habit of making it at Woolwich. This is a model of the gun that I proposed to make *(pointing to the other model)*. I have given all the outlines of my gun and the interior, which has been adhered to; but

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but the service gun is about four tons, and mine is something more than seven tons.

1130. *Chairman.*] Will you be so kind as to read your letter to "The Times" of November 8, 1862?—Yes. "Sir,—In a letter which appeared in 'The Times' of November 6, Sir William Armstrong, while commenting on the late trials of our respective field-guns, near Shorncliffe, has made some statements, the tone of which I regret, and which necessarily call for a reply. With the arrangements at Shorncliffe I had nothing whatever to to, except that I went there expecting to see my guns officially tried, and before going I was unaware that any Armstrong guns were to be fired on that occasion. Sir William animadverts strongly upon the account of the trials which was quoted in 'The Times' from the 'Army and Navy Gazette,' but he does not point to any of the facts as being incorrect, though he has of course every facility for ascertaining their truth. It is necessary to advert to this, because it might be inferred from Sir William Armstrong's letter that the trials at Shorncliffe were of a partial and one-sided character, for he says: 'It would seem that Whitworth and Armstrong field-guns were fired in the presence of Mr. Whitworth, Colonel Boxer, and their friends,' omitting to add, what was distinctly stated in the article quoted by you, that the trials were really official, and 'took place in the presence of the Inspector General of Artillery, General Bloomfield, and a large staff of officers.' Among these were Colonel Cuppage, Colonel Bingham (representing the Horse Guards), Colonel Marriott, and other officers. Sir William, without pointing out any errors, expresses in general terms his doubts as to the accuracy of the statements quoted in your paper, observing that on other occasions different results had been obtained with his guns. This is possible, but I should ask whether in these instances the trials were public or private, and under what conditions they took place? On various occasions public trials of my guns have been made, and the actual results of those trials were all published at the time. It would be very satisfactory if Sir William would point to results obtained by him which he is ready to compare with them: for example, after the Armstrong 32-pounder gun gave a range of 9,175 yards, I obtained with one of my small 3-pounders a range of 9,700 yards, and with a 12-pounder a range of 10,200 yards. Again, my 70-pounder gave a range of 3,000 yards at 5 degrees, and a range of 5,000 yards at 10 degrees. Although Sir William undertook (as stated in Parliament by the Minister of War, the late Lord Herbert) to produce a gun, expressly for range, which should surpass mine (not made expressly for range), I have never heard of his guns having equalled the results given above. When results such as these are openly published, there are surely ample means for making a comparison, each gun being allowed to do all it can without their being fired actually side by side. Why has not Sir William availed himself of this mode of comparison, which was open to us both, had he so desired it? In his letter he now expresses his opinion, that it is high time that a proper and systematic comparison should be made between Mr. Whitworth's guns and his. He therefore admits that no such comparison has yet been made, though the Rifle Ordnance Committee, in 1858, decided in favour of his gun and against mine. In a former communication I alluded in general terms to this subject, but from comments made on my letter in your leading article, it appears that my allusions did not convey sufficient information. It is therefore necessary plainly to state what were the proceedings of the Rifle Ordnance Committee, with reference to the Armstrong gun and mine, when they recommended the former to be adopted for the service. I am now for the first time enabled to give this explanation, having just received the recently published report of the evidence given before the Select Committee of the House of Commons of last session. Its Appendix furnishes me, for the first time, with a copy of the Ordnance Committee's report upon the Armstrong gun and mine, and with a list of the members by whom it was made. Among the most prominent of those members were Sir W. Wiseman, now the Vice-president of the Ordnance Select Committee, and the Secretary, Captain A. Noble, who afterwards become a partner in the Elswick Ordnance Company. From the evidence taken by the House of Commons, it appears that a programme of the trials of the Armstrong gun, proposed to be made in 1858, was previously submitted to Sir William by the Committee, and he consented to it, stipulating, however, 'that he should be allowed to co-operate personally or by his assistants.' No such opportunity was afforded to me, no programme was furnished to me, nor was I even allowed to be present at the trial of my own guns, which were brass muzzle-loading guns, bored and rifled identically with the 12-pounders recently tried at Shorncliffe. I did not know what was the nature of the intended trials nor their results. The Committee, who might have communicated with me in the same way that they did with Sir W. Armstrong, omitted to do so; and, more than that, in a letter from the War Office they promised to visit my works at Manchester, and I fully expected that they would come before they decided what gun they would recommend; but though they visited the Elswick Works, they never came to mine. It was to these circumstances I alluded when I protested against being again referred to a Committee, some of whose members had already decided against me, and who would necessarily see in the success of my guns the condemnation of their previous judgment. Though I object, and I think with reason, to being subjected to the direction of a tribunal so biassed, I accept readily Sir W. Armstrong's proposition to match his guns and projectiles against my guns and projectiles. To bring the matter to a direct issue, I would propose to name two members, and that Sir William should name two, who, with a Chairman chosen by the four, shall form the tribunal of reference. Whatever that tribunal shall agree upon as to time, place, and nature of trial and mode of arriving at a decision, I will accept, in the earnest wish that the result may be advantageous to the public service, and in confidence, without any reserve on my part, that it will be of an amicable nature. Before concluding, there are one or two points in Sir William's letter that require to be noticed. It is true that nearly three years ago propositions were made that competitive trials between Armstrong and Whitworth guns should take place. It was proposed that they should be conducted by the Ordnance Select Committee, and to that I assented, though I felt that, for reasons already explained, some of its members must necessarily be

be influenced against my gun. I asked, however—first, that the trials might be attended by disinterested spectators, such as members of the principal scientific institutions; second, that my guns might be worked by my own men, or men chosen and selected by me; third, that the trials, once begun, might be continued without intermission, so that they might not be prolonged indefinitely. The Ordnance Select Committee conceded the first point, but refused the others. Being very anxious for the trials to take place, I yielded the second point, though it was one which, as has been explained, had been conceded to Sir William Armstrong when the Ordnance Committee tried his guns. As the programme was so long and varied that it would have extended over many months unless carried out without intermission, I was obliged to repeat my request for the third point. The Ordnance Committee persisted in refusing to concede it, and the trials did not take place for this reason. With reference to my 7-inch gun which penetrated the "Warrior" target at Shoeburyness, Sir William complains that I have not recognised my obligations to himself. If he will state which of his inventions has been used in the construction of that gun, I shall be very glad to express my acknowledgments for them. He probably supposes that its inner tube, like that of his gun, is made of welded coiled bars. This is not the case; it is formed of a solid bar, bored out, a construction which he, I believe, does not approve. It is true the gun is built up, and its hoops are made of welded coiled iron, but so were those of guns made by me in 1855. Guns built up of welded coiled hoops were, as Sir William must admit, well known in this country before he introduced his rifled ordnance. Though, for practically carrying out the system, he is entitled to claim full merit, he equally with myself is indebted to those who went before us for the principle of what is termed the coil construction. He has used it in his way for his purpose; I used it in my way for mine. For the ready and able assistance afforded me by Mr. Anderson in the manufacture of my gun at Woolwich, I have already expressed my thanks; but it is only due to myself to state that the gun, besides being rifled on my system, was made to drawings supplied by me. It was of too large a size for my works at Manchester at present to undertake to make it, and for that reason I asked for permission to have it made at Woolwich. Similar permission, it should be remembered, has been readily accorded by the War Office to many others besides myself. I have before stated I should have preferred the gun to be made of hoops, cast in one piece and hammered, instead of being formed of welded coiled bars, and gave my reasons for the preference, to which I adhere. With reference to the use of improvements made by me in artillery and projectiles, I should regret extremely if there could be any doubt that I am, and always have been, desirous that they should be used in every way that can benefit the public service. Sir W. Armstrong well knows that during the last two or three years he has made such experiments as he wished with steel flat fronted projectiles, without any impediments being offered by me, and if he has not done as much with them as my guns have done, it is not the fault of the projectiles. Probably, as Sir William cannot yet see the mechanical advantage their shape gives them over the roundheads, he did not give them sufficient trial. Until I shall have completed the trials of my shells, and fully proved their power at long ranges, I am naturally unwilling that concurrent trials of them should be made, which might not with other guns be more successful than those made with solid projectiles of the same shape, especially when no application is made to me, as is usual in such cases, for permission to use my improvements. When my own experiments are concluded, it will give me much pleasure to see Sir William try, if he chooses, projectiles like mine with his guns; and I repeat here what I have already stated on other occasions, and what I have endeavoured practically to carry out, that my object is to aid as much as I can, and in any way that I can, the public service. If it be to its advantage to adopt the whole or any part of my improvements, I will readily give my assistance in furthering the adoption, without considering the persons who may have to carry it out.—I remain, Sir, yours most obediently, *Joseph Whitworth.*"

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1131. Sir *John Hay.*] With regard to that letter at question 863, page 22, of our last day's evidence, a question was asked of Mr. Anderson with regard to that special letter. "Mr. Whitworth states that he has only to offer his thanks for the assistance afforded him in the manufacture of the gun, but that it was made from drawings supplied by himself." To that question, I see Mr. Anderson answers, "He must have been under a misapprehension when that was written, because the plan was very different from the one supplied by him; I should think it was a mistake." Is Mr. Anderson right in that evidence?—The drawings were not before Mr. Anderson when he made that statement, I presume.

1132. This was on the 23d of March 1863; he produced certain drawings which he said were his drawings, and your drawings, and he said that there was such a considerable difference between them that you must have been under a misapprehension: "the plan was very different from the one supplied by him; I should think it was a mistake"?—I may observe that the statement that I have made to the Committee has been read to Mr. Anderson, and he concurs in that statement.

1133. Captain *Jervis.*] Then in that case he must eat the words which he used before the Committee?—The drawings were not before the Committee, I suppose, when Mr. Anderson made that statement.

1134. Mr. Anderson was asked: "Mr. Whitworth wrote to the papers last year to say that he had not been indebted to the Royal Gun Factory, that that was entirely his own gun, and that you had made no improvement in it, but you made very serious improvements in the plan sent to you, if I understand you rightly?" To which Mr. Anderson replies, "There was some misapprehension with regard to the gun sent to us; it was all screwed together; but the gun that we made was made in the same way as our own guns, except that it had a solid interior, and the inner extremity was closed and not open; it was plugged up, and there were some very good points about that gun." I should like to know whether that statement of Mr. Anderson is correct?—The mode of manufacture at Woolwich is essentially different from my mode of manufacture; so that the gun was left, with regard to the details, to Mr. Anderson to carry out in the best way he could, according to the system practised at Woolwich.

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1135. Sir *John Hay.*] That is Sir William Armstrong's system, which is practised at Woolwich, is it not?—The great difference is this, that the inner tube of the Armstrong gun is made parallel, and the hoops are shrunk on. In my system I make the inner tube a little taper, and put them on by hydraulic pressure.

1136. On the 26th of December 1861, your firm wrote to Mr. Anderson as follows: "We are in receipt of your favour of the 24th instant, and beg to inform you that Mr. Whitworth has just returned from Derbyshire, and has seen the tracing No. W.—82, showing the construction proposed for the 7-inch gun to be made at Woolwich, and rifled on Mr. Whitworth's principle. Considering that the mode of construction which Mr. Whitworth would have preferred, and which we have explained to you, cannot, with the facilities now existing at Woolwich, be conveniently carried out, we will avail ourselves of your offer to undertake the responsibility, and to leave the details of construction entirely to yourself. We may, however, ask you to consider the propriety of omitting the outside hoop shown on tracing W.—82, and welding the next series of hoops together, so as to avoid the joints; this would reduce the weight of the gun to about seven tons. We venture to express a hope that the gun may be proceeded with, with all possible despatch:" is the construction adopted by Mr. Anderson referred to here identically the same with the one you proposed?—It was not the same, for the reason I have mentioned—namely, that the mode of manufacture was so different.

1137. Did it differ very much?—Mr. Anderson was not able to make the gun on the same plan as we do at Manchester, because he had no hydraulic press to put on the hoops with; therefore I was quite willing that Mr. Anderson should make the details of the gun as would suit best his mode of manufacture.

1138. Therefore, did not the gun which he made differ in principle from the drawing of the gun which you sent?—Will the honourable Member explain what he means by the "principle"?

1139. I want to know whether the construction was identical with that drawing which you sent?—The outline of the gun is the same, and the interior of the gun is the same.

1140. Is it throughout the same?—No, it is not throughout the same.

1141. Did Mr. Anderson make any difference from the plan which you sent?—This is the plan of the gun that I sent (*referring to a drawing.*) This is the taper tube; this shows the series of tubes screwed together; that does not show the joints any more than the other gun shows how the hoops were originally made.

1142. But does not the plan which you represent as the one you agreed to, with Mr. Anderson's improvements, differ very materially from the one you sent him?—No; this W. 87 drawing is the drawing of the gun that is now made.

1143. Does not the one construction differ very materially from the other?—As far as the bore is concerned, it is the same; as far as the tube is concerned, it is as near as possible the same; as far as the hoops for the trunion go, it is the same. Then with regard to the breech, there is one single screw in W. 87, and three screws on one stem in the other drawing, that is the essential difference. Then in order to get the tube W. 87 strong enough, it is much thicker, but I do not require it in my drawing to be thick, because I make the screw screw into each of those hoops.

1144. Did not Mr. Anderson consider that alteration necessary, in order to make the gun sound?—I should say not; I think he will tell you that fitting a screw of this character into a gun was rather difficult, because his men and his machines would not be very capable of doing it without experience, and therefore he put in a single screw, and closed the tube; that was his proposition. Now, in referring to the gun which Mr. Anderson proposed, you see there is no screw there; this is made solid; I object to this large solid mass. Then the other drawing has a screw, but the tube is open; I object to that construction, because, as you will see, the area is double that of the bore, and the resistance would not have been sufficient.

1145. Then, as those four drawings are distinctly different, is not it the fact that the one signed by you to be carried out by Mr. Anderson, differed from the one you originally sent?—It differed in the way I described; but not nearly so much as it differed from the other two.

1146. But was it not, therefore, a different construction?—You may, in strictness, say that each of those drawings is different in construction from the other; but Mr. Hulse will be able to explain exactly how the thing came about, as he was in communication with Mr. Anderson.

1147. The gun, as made, is not made according to the drawing sent in by you?—It was made according to this drawing sent in by me, after a conference with Mr. Hulse.

1148. Then that drawing was not accepted by Mr. Anderson?—He was ready to make the gun according to my drawing.

1149. Colonel *Dunne.*] If he had had the means of doing so?—Yes, if he had had the means.

1150. Captain *Jervis.*] You say in your letter, "Considering that the mode of construction which Mr. Whitworth would have preferred, and which we have explained to you, cannot, with the facilities now existing at Woolwich, be conveniently carried out, we will avail ourselves of your offer to undertake the responsibility, and to leave the details of construction entirely to yourself. We may, however, ask you to consider the propriety of omitting the outside hoop, shown on tracing, W.—82, and welding the next series of hoops together, so as to avoid the joints; this would reduce the weight of the gun to about seven tons." To which Mr. Anderson replied, on the 31st of December 1861: "With respect, however, to the removal of the outside coil, I am of opinion that this coil is indispensable to the strength of a gun constructed on the plan proposed; and with regard to the welding of the series of hoops under the exterior coil, these hoops are of a much larger diameter than we have yet done, and I am unwilling to run any risk with this gun." Therefore, was the drawing which you approved of, as altered by Mr. Anderson, the same drawing as you sent in?—The drawing which I approved of was as nearly as possible the drawing which I spoke of at first. The drawing of the gun, as it was made, is as near as possible to this first drawing, which I sent in; it is far nearer to that first drawing than to either of the two others.

1151. But, looking to the construction of the breech itself, is it not distinctly different?—I have explained that.

1152. But

1152. But does it not, as a matter of fact, differ?—The Honourable Member sees how much it does differ.

1153. You admit it does differ?—Of course it differs.

1154. Therefore, the gun, as made, was not made according to the drawing supplied by you?—It was made as nearly as possible according to the drawings supplied by me as the system of manufacture admitted.

1155. Mr. *Vivian.*] It differs on account of the inefficiency of the machinery which the authorities have at Woolwich?—I think so.

1156. Would you have preferred that your original drawing should have been carried out?—Undoubtedly.

1157. Taking the essence of the gun, I find you distinctly state in your letter to the "Times," that "the gun differs in construction from the rifle guns of the service; its metal is differently distributed, its form is different, and it has a fixed breech, being a muzzle-loader." Now, I presume that you meant thus to define what your expression, "different in construction," indicated?—Yes.

1158. First, as to the distribution of metal: now, is there any material difference between the distribution of the metal in the gun which was ultimately made, and your original drawing?—No, there is no difference.

1159. Is there any material difference in the distribution of the metal of the gun, as originally designed, and that which is now completed?—If this line, which is the thickness of the tube, were continued through them, you would see that there would be scarcely any difference in the distribution of the metal. If this hoop, which Mr. Hulse suggested, were put upon that, you would see that the distribution of the metal is only different in this hoop *(referring to the drawing).*

1160. Then that outside hoop was suggested by Mr. Hulse, your partner?—Yes.

1161. Then taking the section of the gun as originally designed, and adding that hoop and taking the section of the gun as completed, what difference was there in the thickness or distribution of the metal at the breech?—They are practically the same.

1162. Then the gun was practically finished, the same as the one originally designed, with regard to the distribution of the metal?—Undoubtedly.

1163. Then with regard to the form, is there any difference with respect to form in the gun as finally completed as compared with the gun as originally designed by you?—No.

1164. What do you define to be the "form" of the gun?—The form I should consider the outside dimensions. The external form is shown by the section; the weight giving the form.

1165. Now, is there any material difference in the gun as completed and the gun as originally designed by you in the external form as shown by the section?—No. I may perhaps explain, that we make the guns of homogeneous metal or steel, and its specific gravity is greater than that of wrought-iron; it is 1 in 15 heavier; and therefore we made this gun, which had to be made of wrought-iron, larger in diameter, in order to have it of the same weight as the gun made of homogeneous metal.

1166. Then I understand that the enlarging of the diameter by the external hoop was the suggestion of your partner, Mr. Hulse?—Yes, and that is the only difference.

1167. Then as shown by the single line, the external form of the gun remained the same when completed as when designed by you, with the exception of that addition made by your own partner?—Yes.

1168. With regard to the breech, I understand you to say that you designed that the breech should be composed of three screws, or rather that the breech piece should be solid, and should have upon it three screws upon steps?—Yes.

1169. While the gun, as completed, had a solid breech piece with one screw?—Yes.

1170. Why was the original plan departed from; was it because you considered that one screw was better than three, or was it from the inability of the machinery at Woolwich to carry out the form of screw which you designed?—I considered the three screws infinitely better than the one screw, but more difficult to accomplish by men who had not had experience.

1171. I presume that explains the expression in your letter of the 26th December: "Considering that the mode of construction which Mr. Whitworth would have preferred, and which we have explained to you, cannot, with the facilities now existing at Woolwich, be conveniently carried out"?—That was one of the points.

1172. Sir *John Hay.*] Has anybody ever accomplished a solid breech with three screws upon it?—I should say not.

1173. But should you have any difficulty in undertaking it in your works at Manchester?—No difficulty whatever.

1174. Have you made such guns?—Yes.

1175. You meant just now that no one had ever made such a screw but yourself?—Precisely.

1176. Of that size?—Of any size.

1177. Mr. *Vivian.*] I see that after drawing a distinction between your drawing and the drawing upon which the gun was eventually constructed, and stating that one is 28 inches in diameter and one 31 inches in diameter, although they make no mention of the fact that the external ring, to which the three additional inches are due, was the suggestion of your own partner, the Ordnance Select Committee in this report go on to state that "its metal is not differently distributed from that of the service guns, and its form is not different in any degree worth notice." Now I ask, whether the distribution of the metal and the form of the gun are different from the ordinary service gun, and, if so, in what respect they differ?—It is essentially different. I have not a section of this gun, but the outward form and its weight are seen by the models.

1178. Do those two guns represent the same internal bore?—Yes, precisely.

1179. They are both 7-inch guns?—Yes.

1180. And they accurately represent the distribution of the metal in the service, and the distribution of the metal in the gun which you designed?—Yes.

1181. Could you, adopting the suggestion made by another Member, mark upon the drawings which you have furnished the section of the ordinary service gun?—Yes.

1182. Was the Ordnance Select Committee justified in making this statement with regard to your gun: "Its metal is not differently distributed from that of the service guns, and its form is not different, in any degree worth notice." Is that the fact or not?—I think when the Members of this Committee see the section of the gun, they will find how very different the two are.

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1183. Then, I presume, when you requested Mr. Anderson to undertake the carrying out of that design, you did so from a feeling that he was better able to carry it out, being, in fact, in practical charge of the machinery and the workmen who were to do so?—Yes.

1184. The weight of your gun, I think, is seven tons, and the weight of the ordinary service gun of the same bore four tons?—Mine is a little over seven tons.

1185. Sir *Frederic Smith.*] In principle, the gun submitted by you, and the work executed after the improvements or alterations made by Mr. Anderson, are substantially the same?—I think so.

1186. The detail is different!—Yes.

1187. Which detail you would have left to your own people, if you had been at a distance, as well as you did to Mr. Anderson?—Yes.

1188. Captain *Jervis.*] Do you mean to say that in your absence you would have given as much authority to one of your foremen to construct a gun of this nature as you gave to Mr. Anderson?—Yes, to the extent of adopting suggestions rendered necessary by the nature of the means he had to work with.

1189. Then why did you wish the gun to be made at Woolwich?—We had never made a gun so large.

1190. Had they at Woolwich?—Yes, they were in the habit of making much larger guns than 4 tons. What is the weight of the heaviest gun I really do not know. They had machinery that was quite proper for making a 7-ton gun. I am not aware that there was any thing requiring new machinery to make it.

1191. Mr. *Laird.*] They could not have made the gun in the same way that you do, from the want of the machinery?—No.

1192. The only variations are those you have pointed out, and they could not have made the gun with three screws?—Not conveniently.

1193. Sir *John Hay.*] Did you say that you had made, at your works at Manchester, guns of this construction, with the three-stepped breech piece?—The 5½-inch bore gun we have made precisely the same as this, except that in the 5½-inch bore we put in two steps instead of three, it not being so large a gun.

1194. Have the three steps ever been completed by you?—They are in hand.

1195. And is that made with coils and hooped externally to the homogeneous metal tube?—All the hoops we make now are made of homogeneous metal.

1196. In coil?—No, in rings, in cylinders, or hoops.

1197. But they differ from the construction of the gun which was made at Woolwich in the fact that they are in rings or cylinders and not in hooped coils?—Yes, precisely; we have no welding in our gun.

1198. But there is that difference of construction between the gun we have been just speaking of, the 7-ton gun, and the guns you have made at Manchester, that the strengthening hoops are here made of coils of wrought-iron welded together, whereas your hoops are made of homogeneous rings or cylinders which encircle the inner tube?—Yes.

1199. Then there is that difference of construction as between the two guns, that this gun now before us is made with hoops of wrought-iron, on the coil system, whereas your guns at Manchester are guns made with cylinders of homogeneous metal?—Yes, but I would explain that, supposing the cylinders to be made of coils and welded; I should prefer them to be put on by hydraulic pressure, and not to be shrunk on.

1200. Captain *Jervis.*] In your original drawing was the breech piece to be a solid forging?—Yes, the one with the three screws would be solid.

1201. The three screws would not be a solid forging, would it?—Yes, made of homogeneous metal.

1202. But that is not a solid forging, is it?—Yes, it is solid, and forged under the hammer.

1203. And there was in your original drawing the intention of having a solid forged breech piece?—Yes.

1204. Mr. *Laird.*] Is the coil principle Sir William Armstrong's invention; was he the first to adopt it?—No.

1205. Were there patents taken out before him for the coil principle?—Yes, many years since; I used the coils in 1855.

1206. Mr. *Vivian.*] Are not all fowling-pieces made on the coil principle?—Yes; the barrels of fowling-pieces are coiled.

1207. Captain *Jervis.*] You do not draw a comparison between the coil principle of a gun barrel and the coil principle as adopted by Sir William Armstrong for strengthening the gun, do you?—The one is hooped with coils, and, as far as the tube is concerned, it is made in the same way as the old fowling-piece barrel.

1208. Have you got that gun which you made in 1855?—The gun I allude to was not finished; we have the parts of it.

1209. It was never completed?—No.

1210. Was there ever one coil put over the other before Sir William Armstrong did it?—In that gun we had not the coils one over the other, but in my patent of 1854 I described that process.

1211. Did you do so in the provisional specification which you took out?—Yes, it is in the specification.

1212. Do you mean No. 2525?—There was only one in 1854; I do not know the number.

1213. Will you show me whereabouts in the specification it is mentioned (*handing a copy of the specification to the Witness*)?—I will look into that point before the next meeting of the Committee.

Jovis, 23° *die Aprilis*, 1863.

MEMBERS PRESENT.

Mr. Baring.	Captain Jervis.
Mr. Beecroft.	Mr. Laird.
Lord Robert Cecil.	Mr. Monsell.
Mr. Dodson.	Sir Morton Peto.
Colonel Dunne.	Sir Frederic Smith.
Sir John Hay.	Mr. Vivian.

THE RIGHT HON. WILLIAM MONSELL, IN THE CHAIR.

Field Marshal His Royal Highness the Duke of CAMBRIDGE, K.G., Examined.

His Royal Highness the Duke of *Cambridge*, K.G.

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1214. *Chairman.*] YOUR Royal Highness is the Commander-in-Chief of the Army?—Yes.

1215. How long is it since your Royal Highness has held that appointment?—Since the death of the late Lord Hardinge, in July 1856.

1216. I need hardly ask you whether your attention has been specially directed to the question of rifled artillery?—It has.

1217. Is your Royal Highness satisfied with the guns and material now in the hands of the Royal Artillery at home and abroad?—That I am satisfied is perhaps more than I can say. I think that probably, with our present experience, we have as good a weapon as we can expect to have, but that it is a perfect weapon I cannot say.

1218. What were the circumstances that led to the appointment of the Select Committee, the report of which has been laid before us, and to which Colonel Bingham referred?—The committee was assembled at my request.

1219. "A committee of artillery officers assembled at the Horse Guards on the 17th November 1862, by order of his Royal Highness Field Marshal Commanding in Chief, with the concurrence of the Right Honourable the Secretary of State for War"?—The reason that that committee was assembled was shortly this, that in the course of the year 1862, at the end of the practice season, a very great number of reports came in that the field guns in the possession of the batteries of the Royal Artillery showed many defects, as the result of the practice. The consequence was, that I felt so strongly that it was of immense importance not to shake the confidence of the country, and particularly of the corps of artillery in their guns, that I thought the time had arrived when it was essential to find out why they were defective, and whether in any way they could be amended. Up to that period we had had no complaints of great defects, such as we had in 1862.

1220. I think Colonel Bingham mentioned in his evidence, that somewhere about half the guns are now liable to objections; is your Royal Highness aware of that fact?—That of course depends entirely on whether they are lined guns or not. That committee reported that the guns were defective, because they had been lined; and it appears that one-half of the guns at least are lined. Therefore, if the conclusion arrived at in that report be correct, that the lining of the guns was the cause of their being defective, it results that half the artillery guns (if lined) are defective. But that is only of course the result of that view of the case.

1221. But putting aside the experiments tried at Shoeburyness, could your Royal Highness state in how many instances the Armstrong field guns have been tried with rapid firing, as they were tried at Portsmouth and Shorncliffe, and Dublin?—They were tried in China; there are two field batteries of Armstrong guns in China.

1222. I meant experimentally?—No; those are the only cases that I know of.

1223. It appears by Captain Gordon's evidence, which I will put into your Royal Highness's hands, and by the certificate which Captain Gordon produced, that the committee were under a misapprehension when they stated that the guns which failed were received into the service without passing through the department of the Inspector of Artillery. May I ask your Royal Highness, whether the failure of those guns is not then properly attributable, not to the absence of an independent inspection, but arose from the circumstance of there not being an artillery officer at the head of the Royal Gun Factory?—My opinion is that it would have been a great advantage, and that it would be a great advantage if there were a Royal Artillery officer at the head of the Royal Gun Factory; and I am convinced that the confidence of the country, and the army in particular, would be very much increased if it were so; but I also think that an independent inspection besides that is essential, and therefore I attribute to both causes the fact of there being improper guns issued.

1224. It is stated that several of the Elswick guns which were sent out to India have failed. Now those guns were subjected to an independent and, I believe, a very severe independent inspection on the part of an inspector of artillery?—I have no knowledge of any failures of guns in India; but I know that all Elswick guns are inspected, as I think they ought to be inspected.

1225. Would it be possible for an independent inspector, not meddling in any way with the manufacture, and not going into the department where the guns were manufactured, to conduct any very efficient inspection of such delicate articles as Armstrong guns are?—I see no difficulty in an inspection, perfectly independent, taking place without the slightest interference with the head of the department, either of the

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Laboratory or of the Carriage Department, or of the Foundry Department.

1226. But does your Royal Highness consider that such an inspection would be very likely to be an efficient inspection, the inspector not seeing the article in the process of manufacture, but merely inspecting it when finished?—I think it would be just as efficient an inspection as you would have of any contract article. As the system now exists, every contract article goes through a most rigid inspection. I cannot see that there is more difficulty in such an inspection of anything manufactured at the Arsenal, than there would be in the inspection of a contract article.

1227. But would your Royal Highness permit me to ask whether the reason that we manufacture so many articles in the Arsenal is not that we find it impossible to conduct an efficient inspection of the contract articles?—No doubt there is great security in having the articles made under your officers in the Arsenal, and there is no doubt a double responsibility, because the head of each department is responsible for what he produces; but I see no reason why there might not be another intermediate responsibility before issuing the articles, which would be that of an independent inspector of artillery.

1228. Do I gather your Royal Highness's opinion to be, that this independent inspector, this new officer, shall have nothing in the world to say to the manufacturing department, and should never see the articles manufactured until they were delivered into his hands?—I think it would be much better if he did not interfere with the departments, and that he should only inspect the articles after the branch declared that it has produced the article which it is called upon to produce.

1229. It appears by the evidence of Mr. Anderson, that he does not consider himself bound to abide absolutely by the sealed pattern, but holds himself at liberty to make trifling deviations in the Armstrong guns?—I think it is the most extraordinary statement I ever heard; it was perfectly unknown to me, and if I had known it before, I should have considered it my duty to represent it to the Secretary of State for War; such an arrangement as that is most objectionable in every way; I never heard of it until I read that evidence.

1230. Can your Royal Highness state who is responsible for the sealed patterns?—The Select Committee recommend whatever they have passed as desirable for the service, and they put upon it a seal of their own as a safeguard, indicating that that is the article which they have had before them, and which they have passed. After that the Secretary of State for War submits the case for the opinion of the Commander-in-Chief, and if the Commander-in-Chief concurs the Secretary of State for War then issues his instructions that that article is to be adopted; and upon that the article itself is again sealed by my orders, that duty being carried out by the Deputy Adjutant General of Artillery, and then it becomes the fixed pattern; in fact, each article has a double seal; the seal of the Select Committee, and then the seal of the Commander-in-Chief, under the authority of the Secretary of State for War.

1231. It would appear that you consider the Select Committee primarily responsible for the sealing of the pattern of this lined gun?—Certainly.

1232. Captain *Jervis.*] The question we have to inquire into is with respect to the proper expenditure of these monies during several years. As your Royal Highness has been Commander-in-Chief since 1856, you will remember the position this country was in with regard to rifled ordnance compared with France and other countries. Are you of opinion that the expenditure which has taken place, though some guns have failed, has materially assisted in putting this country into a proper position with respect to armaments of war?—No doubt of it. The Armstrong gun is the best gun as far as we have gone; it is not perfect, but it is the most perfect system we have yet had laid before us.

1233. There has been no other gun, you think, brought to your notice which you consider superior, and which you would endeavour to have brought into the service instead?—Not in such a state that you could issue to the service. I am not saying that Mr. Whitworth's gun is a good gun or not (I name him because his gun is now under experiment), but it has never been introduced as a system so completely as the Armstrong gun. We have no shell at all of Mr. Whitworth's for field guns.

1234. You are not aware yourself of any gun which is in that condition or state of perfection that you would wish at the present moment to have in the service rather than the Armstrong gun, or which leads you suppose that the expenditure ought to have been made upon any other system than the present?—Certainly not.

1235. Colonel *Dunne.*] When was your Royal Highness first made aware that the gun we have been speaking of was a lined gun?—I have only heard it since the statement was made in this room. It was a most improper thing, because it was not intended. A specification was made, and in the specification there was nothing about lining. It seems to me a most unjustifiable alteration of the pattern.

1236. Is not there a difference between a gun lined throughout and a patched gun, it having been stated in this room that the guns that fail were patched guns?—I presume a patched gun would have been altered because of some flaws, but as far as I understand the system, I should have thought that a lined gun was not a desirable gun, though I am not sufficiently scientific to give an opinion upon that.

1237. *Chairman.*] Would you extend the opinion which you have given about inspection to all branches of manufacture for the service?—I cannot understand what objection there can be. The only objection that strikes me is that there might be something to find fault with. If I were at the head of any of those departments I should court inspection. I say that not with the idea that their manufacture is bad, but because it would prove to the world and to the service that what they produce—what they are supposed to produce—is really what they do produce, which could only be ascertained, I think, on inspection.

1238. Sir *John Hay.*] That would give much more satisfaction to contractors, would it not?—I think it is very invidious as between the contractors and the manufacturers of the Government, that the articles of the contractor should be inspected and the other articles not.

1239. Mr. *Beecroft.*] Do you think that the Whitworth guns have been sufficiently tried to enable us to draw a fair comparison between the Whitworth guns and the other guns that have been

been tried?—I cannot say that the Whitworth guns have been as much tried as Sir William Armstrong's, but I believe it will be found that there has been a great deal of difficulty in carrying out the trials. Mr. Whitworth has, I believe, made a good deal of difficulty in respect to some of the proposals made to him, and that I know has considerably delayed the trials which were intended, and which were in fact ordered. At this moment, I believe, there is a very careful investigation going on as regards the two systems, the Armstrong and the Whitworth; upon that, of course, I can say nothing yet, as I have not seen the evidence.

1240. Do you think that their different merits have been sufficiently tested to enable us to draw a fair comparison between the two?—I think, considering the facilities given by Sir William Armstrong, and the difficulties thrown in the way by Mr. Whitworth, that everything has been done that Mr. Whitworth could possibly have expected, but I do not think that there has been so much testing of Mr. Whitworth's gun as of Sir William Armstrong's gun, because Sir William Armstrong has never made any difficulty about any test, and I think Mr. Whitworth very often has.

1241. Mr. *Baring.*] Do I understand your Royal Highness to state that difficulties were thrown in the way of Mr. Whitworth?—No, by Mr. Whitworth himself; I believe that on several occasions proposals were made with respect to how the trial was to be conducted as to Mr. Whitworth's and Sir William Armstrong's guns, and Mr. Whitworth has frequently objected to the trials being so conducted, and then it has been put off or delayed.

1242. The committee which is now appointed to compare the merits of the two guns has not commenced its experiments, I believe?—They have not reported, but they have been sitting constantly.

1243. But the experiments have not been completed?—No, they have only had preliminary meetings, and I believe that they are waiting for the guns to be produced to carry out those experiments.

1244. Is your Royal Highness satisfied with the constitution of that committee, your Royal Highness representing the artillery?—Yes, I think it is very well constituted.

1245. And impartial?—I should imagine that it is as impartial as any committee that could be appointed.

1246. It is entirely distinct from the Ordnance Select Committee, is it not?—Entirely.

1247. So that no possible bias which the Ordnance Select Committee might be supposed to have with respect to either system could apply to the committee as it is now constituted?—I should say not the least.

1248. I believe that your Royal Highness was in communication with General Peel when he was the Secretary of State for War, when the Armstrong gun was first introduced into the service?—I was.

1249. Can your Royal Highness say that that decision was with your concurrence?—Entirely.

1250. Has your Royal Highness seen any reason to repent the conclusion come to by the Secretary of State for War with your concurrence with respect to the introduction of the Armstrong gun into the service?—No, not the least, because there has not been so complete a system, in my opinion, laid before us as Sir William Armstrong's: there may be other very good guns, but in completeness Sir William Armstrong's system surpasses any that we have yet had laid before us.

1251. With respect to any foreign system of ordnance, would your Royal Highness consider that our ordnance would bear a favourable comparison with that of any other army?—My conviction is that we are ahead of any other country.

1252. And that result must have followed from the decision come to by the Government with respect to the Armstrong system of ordnance, and the improvements since introduced into that system?—Yes, assuredly.

1253. Colonel *Dunne.*] Are you aware of the date of the order that the inspection should cease by an inspector of artillery?—It was when Lord Herbert was Secretary of State for War.

1254. But it was not with your consent?—I have always held a very strong opinion that an inspection should take place.

1255. Sir *Frederic Smith.*] In the engineering departments the officers at the various stations are, I believe, responsible for conducting the work according to your orders and the Secretary of State for War's orders, and if you have an inspector general of engineers, and you think that quite necessary when there is a local officer; it is upon the same principle that you think the departments now in question should be inspected independently?—Quite so; my idea of the officer at the head of the Arsenal is, that he should be very much in the same position as an admiral, or commodore, or captain superintendent of a dockyard; with respect to the different departments of such an establishment, as far as I understand, he does not interfere with the master shipwright in his scientific arrangements, or with any other officer in a like position, but he superintends the whole, and takes care that the whole working of the machinery goes on together. To me it is a most extraordinary thing that when you make a gun that gun is to be made by three separate departments, every officer being totally distinct, knowing nothing, and, in fact, not being necessarily called upon to know anything of the work which the other officers are doing. I must do the justice to the officers at the heads of the establishments to say that they have done their work very well, and that it is astonishing that there has not been more inconvenience resulting from that state of things.

1256. In fact, the system your Royal Highness recommends would produce greater harmony in action between the various departments?—I think the system at the Arsenal is admirable, but it wants that one person to bring about that unity and harmony of action which, in my opinion, does not exist now.

1257. Mr. *Vivian.*] Has your Royal Highness's attention been drawn to the experiments recently made at Shorncliffe, which are detailed in the paper marked No. 8; it appears that the J and K batteries were experimented on, and that 123 rounds were rapidly fired, the result of which seems to have been that several guns were very seriously damaged; in the K battery there appear to have been two guns so seriously injured that they were required to be sent to Woolwich, and I believe that that was the only experiment which has hitherto been made of rapid successive firing, and it seems alarming that two guns out

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of 12 should have given way in so short a period; has your Royal Highness's attention been drawn to that fact?—Yes, certainly, but it was not the only experiment of the sort, because there was an experiment which I asked might be made, and at which I was present at Shorncliffe, last year, where 12 guns had 100 rounds fired as rapidly as possible, and at the end of the firing, which lasted under two hours, there was not a single flaw of any description or kind in any one of the 12 guns; that was at a range of from 300 to 3,000 yards.

1258. Sir *John Hay.*] Were those lined guns?—No; I apprehend that those 12 guns that I am alluding to at Shorncliffe were not lined guns.

1259. Mr. *Baring.*] The conclusion which I understand your Royal Highness to draw is, that those lined guns, although they had stood proof at Woolwich, yet, when tried for the service, were found to be not fit for the service?—I do not believe that those guns were ever proved as I think they ought to be, and that is one of the reasons why I think an independent proof is essential.

1260. I believe that the system of lining guns has subsequently been abandoned?—In consequence of this Report of the Select Committee, it has been thought advisable, as I believe, at once to stop all lined guns, and they are no longer to be made.

1261. Mr. *Vivian.*] If we look to the history of the particular guns composing the K battery, we find that No. 250 is not stated to have been lined, but it is stated that after proof it appeared perfect; it does not therefore seem positive, does it, that those guns were lined?—My reason for supposing that they were lined was, that the Report of the Committee was that they considered the flaws were owing to their being lined guns; but it is possible, of course, that some of them were not lined.

1262. Mr. *Baring.*] It would appear from what is stated at the bottom of page 3, that the guns were lined, would it not?—Yes, I think so.

JOHN ANDERSON, Esq., called in; and further Examined.

J. Anderson, Esq.

1263. Mr. *Vivian.*] WITH respect to gun No. 153 of the K Battery, it is stated in the report before me, after the word "history," that this gun was not bouched. Now, as far as your memory serves you, will you inform the Committee whether that gun was lined?—I will endeavour to find that out before I am examined again before this Committee.

1264. Will you settle that point with respect to No. 153 and No. 250, K Battery?—Yes.

JOSEPH WHITWORTH, Esq., called in; and further Examined.

W. W. HULSE, Esq., called in; and Examined.

J. Whitworth, Esq., and *W. W. Hulse*, Esq.

1265. Captain *Jervis.*] YOU stated the other day that you would point out that part of the patent where you had taken out a provisional specification for coiling?—It is in page 3.

1266. That is not the provisional specification?—No, it is the specification; but the Honourable Member is mistaken about the coiling. I think I have taken out no patent for coiling. There is nothing in the specification to indicate that.

1267. I understood from you the last time that you said there was?—No. I understood the question to be merely with regard to the second series of hoops which is mentioned in the specification, page 3, line 20.

1268. I thought you referred to the coiling?—It is in the specification, but not in the provisional specification.

1269. Is it in either?—Not the coiling of hoops.

1270. Mr. *Vivian.*] But there are rings in the original specification?—Yes, page 3, paragraph 20, "A second series of belts" (which is a term different from hoops) "may be used outside the others, for giving additional strength." What I understood the Honourable Member to ask me was, whether I could point out in the specification a second series of hoops.

1271. Captain *Jervis.*] No; I understood you to say that you had made a gun in 1855 on a similar principle to Sir William Armstrong's coil principle, that you had taken out a specification in 1854 to do so; and you said that you would let me know to-day?—No, I never had any idea of patenting the system of making coiled hoops in 1854; the coils were patented before. In a letter, in answer to the "London Review," you will see that explained.

1272. Mr. *Vivian.*] What is the difference between a coil and a ring or belt?—A belt is a hoop, and that is made generally of coiled iron.

1273. Then what is a coil?—We term it a coil when it is wrapped round previous to the welting.

1274. Sir *John Hay.*] The one is a continuous bar and the other is a simple ring, united to another ring by welding, but the continuous bar is not only united by welding but by its own continuity?—Yes, it is welded lengthwise; sometimes a ring is made by simply bending the iron and welding it together.

1275. But in one case it is a spiral continuous bar whirled round and round a cylinder of the same circumference as that which would be hooped by the rings, but in the other case the continuity gives additional strength to the coil besides the welding process, whereas the rings are only united by the welding?—Yes.

1276. Mr. *Beecroft.*] The ring is simply a barrel?—Yes.

1277. Mr. *Vivian.*] Then what I presume you meant was simply that you had in 1854, in your patent, mentioned the process of external strengthening by rings?—Yes, in connexion with forming the iron tube of segments; that would be very difficult to describe; this is a model of what is shown in the specification, and there are the segments held together by the hoops (*producing a model*).

1278. Captain *Jervis.*] In fact it is in the same way as guns were made 600 years ago?—No, it is very different to those; there were segments but not rifled segments; I am afraid they did not think of that 600 years ago.

1279. Mr. *Baring.*] Do I understand you to say that there is no difference between hooping a gun for strengthening and the coiling system as carried out in Sir William Armstrong's ordnance?—Hoops had been made previous to Sir William Armstrong and myself for hooping ordnance, but Sir William Armstrong made his inner tube of coiled iron, which I think had never been done before.

1280. I wish

1280. I wish to know whether you say there is no difference between hooping a gun for strength and the coil system (which is totally different from hoops) carried out by Sir William Armstrong in his ordnance?—Sir William Armstrong's hoops are made of coils; the hoop is made from the coil, the coil does not exist independently of the hoop; the hoop is made from a long bar of iron, which is wrapped round and then welded.

1281. Putting the hoop over a gun for strength is one thing?—Yes.

1282. Making that hoop of coils is a separate thing?—You may make the hoops in different ways.

1283. And making it of coils is quite distinct from making it the other way?—Of course.

1284. Now the system of coils is in order to gain, as I understand, a greater power to resist lateral pressure?—Exactly; greater circumferential strength.

1285. And, therefore, making the hoop a coil in regard to circumferential strength is a totally different thing from making the hoop in any other way?—Yes.

1286. You used in your letter to "The Times," as to making the gun of coils, these expressions: "It is true the gun is built up, and its hoops are made of welded coiled iron, but so were those of guns made by me in 1855;" that is to say, the hoops of the gun were made of welded coiled iron?—Yes.

1287. You say that guns made by you in 1855, were made with hoops made of welded coiled iron?—Yes.

1288. What became of those guns?—That was a gun made, as this model is made (*producing a model*); it was three parts finished; the hoops were made on the coiled system; and finding in my experiments that I could fire very long projectiles by using a quick rifling turn, I abandoned this segment system; the first gun that I made was made in segments of cast iron, and was hooped with hoop made from coils.

1289. How many hoops had it?—Eight hoops.

1290. They were made of coils?—Yes, they were made of coils; that was a 20-pounder gun.

1291. Was one hoop a-top of another?—No; one series of hoops.

1292. I was confining myself to guns made, was that gun finished?—No, not finished; we abandoned the segments for the reason I have given; I wanted to use cast iron, and that being brittle, I divided it for the purpose of expansion.

1293. That gun was not made?—No; it remains now as it was.

1294. So in 1855 the gun made of welded coiled iron was not finished?—No; the gun made in 1855 of welded coiled iron was not finished.

1295. Was any other gun besides this finished in 1855?—I think not in 1855.

1296. Then what guns do you refer to when you say, that guns made by you in 1855 were made with hoops made of welded coiled iron?—I referred to the one I have mentioned, to this one that I hold in my hand, which we fired a great deal, and also to another.

1297. I thought you said the gun was not made?—The 20-pounder was not made.

1298. Was any gun made?—Yes; this was made and fired a great many times, and another also was made (*producing two models*).

1299. What size was that?—We call that a 10-inch gun.

1300. That was merely a small model?—It is not the model of a larger gun; it is the thing itself.

1301. That very small gun was made as an experiment?—Yes.

1302. Is that all you allude to in this letter to "The Times," in which you say, "Guns made by you in 1855, were made with hoops made of welded coiled iron"?—That was the first one, the 70-pounder gun now at Woolwich; the first 70-pounder breech-loading gun that went to Portsmouth, and was tried at Southport, was made of hoops coiled.

1303. You say, guns made by you in 1855 were made with hoops made of welded coiled iron; is that little experimental gun the only one?—That was the commencement, in 1855.

1304. Was it the only gun made in 1855?—There was the 20-pounder.

1305. Was the 20-pounder finished?—No, I have said not.

1306. Therefore, there was no other gun made in 1855?—Except the gun I am now showing; a gun 10 inches long, and a gun 13 inches long.

1307. As an experiment?—Certainly, they were all experimental guns; and the 20-pounder was an experimental gun.

1308. Mr. *Beecroft.*] Did you make any guns after 1855, partly made from coils welded?—Yes.

1309. What size?—The 70-pounder was made so.

1310. In what year?—I do not remember the date.

1311. Those guns were made with hoops made from coiled iron, welded?—Yes; the difference between Sir William Armstrong's gun and mine in this respect is, that I have always used an inner tube, which has always been made from a solid bar, not coiled. Sir William Armstrong has used an inner tube of coiled iron, as well as the hoops; that I have myself never used.

1312. Mr. *Baring.*] Do you recollect whether Sir William Armstrong in his first guns used coils or forged iron?—Sir William Armstrong, in a letter of his, stated that when he did make the gun with an inner tube made out of a solid forging instead of from coiled iron, he did not approve of it.

1313. Are you not aware that the first guns made at Woolwich were made with an inner tube of solid forged iron?—No, I am not aware of that.

1314. And that that system was abandoned, because Sir William Armstrong considered that for the larger calibres of guns it was not so strong?—Yes.

1315. Take this particular 7-ton gun that was made the other day of solid forged iron; how was that made?—That was made out of a solid bar.

1316. Do you think that that is stronger than the coil?—I do not approve of either. I have never yet made a gun with a tube of welded iron; I never would think of doing so.

1317. You prefer steel?—I prefer a mild steel, or what is called homogeneous iron. Its use for the inner tubes of my guns I consider a distinctive feature. Sir William Armstrong says, in his letter to "The Times" of November 28, 1861, "Before the difficulties of manufacture of the heavy guns were fully mastered, and during the first pressure of the demand for them, I was compelled for a time to make the inner tube—contrary to my principle—from a solid forging, instead of from coiled iron, and the result has proved the inferiority of the plan. But this circumstance, instead of being an argument against my mode of construction, only proves its superiority

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riority over the alternative system of making wrought iron guns out of solid blocks of that material." But every gun which I have made has had an interior tube of a metal that has been cast first and hammered afterwards. I believe the very worst material that can be used for a gun is welded metal.

1318. Mr. *Beecroft.*] Are Sir William Armstrong's guns entirely composed of coiled iron, welded?—Yes, the inner tubes as well as the outer hoops are welded coiled iron.

1319. The guns being really composed of welded iron on the coil principle throughout?—Yes.

1320. Mr. *Vivian.*] Is there anything new in the system of coiling iron to make guns?—No; that has been practised many years for the outer hoops.

1321. Are not all small guns made from coiled bars?—Yes, fowling pieces were so made.

1322. There is no novelty in getting the requisite strength for a gun by using coiled iron?—No, it is quite old.

1323. Mr. *Beecroft.*] They are called twisted barrels?—Yes.

1324. Which agrees with the coiled principle?—Yes.

1325. Captain *Jervis.*] Did you ever hear of any fowling piece made of a twisted bar, strengthened by a twisted bar shrunk over it?—No.

1326. You never saw such a thing?—No.

1327. Is that gun which you have now produced, the gun which you referred to as having been made on the coil principle, in your evidence of Monday last?—No.

1328. You had a 20-pounder gun in 1854?—Yes, that is the gun I alluded to.

1329. Do you remember when you first directed your attention to the question of fire-arms?—In the year 1854; I could not give the exact date.

1330. I think at that time you were nominated one of the members of a committee appointed to consider whether the machinery could not be improved for the making of gun barrels?—No, I was not on any committee.

1331. Was there not a committee appointed in March 1854, or between that and June, consisting of Mr. Westley Richards, yourself, Captain Warlaw and myself?—That was a later committee.

1332. What committee was the first one that you were on?—A committee, consisting of Captain Jervis, Lieutenant Lutzens and Mr. Westley Richards; that was August 19th, 1854.

1333. Can you remember what the directions to that committee were?—They were appointed to assist me in carrying out the experiments at the rifle gallery which was then contemplated.

1334. But we have it here from the War Office, and I think it is correct, that "Mr. Whitworth first came under the notice of the Board of Ordnance in connection with a proposition made by him, in March 1854, to undertake, on behalf of the Government, a series of experiments, with a view of securing by the help of machinery the greatest possible exactitude in the manufacture of rifle barrels." Am I right in stating that before that you had not devoted much attention to the subject of projectiles or the manufacture even of small arms?—Why, the way it originated was this. A committee was appointed by the Government to visit the various manufactories in England and Scotland, and amongst others they visited mine.

1335. What committee do you refer to?—I have not got the names, Mr. Anderson, I remember, was one member.

1336. *Chairman.*] It was before Lord Raglan went to the Crimea?—Yes; it was called the Committee of Machinery, I believe.

1337. Captain *Jervis.*] I was asking whether previously to that time you had turned your attention to the practice of manufacture of large ordnance or small arms?—I had not.

1338. I find that, on the 13th of October, it is stated "The committee had done nothing; Mr. Whitworth saying he was not ready for them, although the shed was complete." Up to October 1854 the time was occupied by the building of the shed. I think your attention was chiefly turned for some considerable time after that to trying to produce a better machinery for the manufacture of gun barrels?—Lord Panmure, when he was Secretary of War, desired that I should furnish a narrative of what I had done, and there is a very short paragraph which will explain that. In a letter which I addressed to Lord Panmure at his request, dated the 13th of June 1857, I said, "In the beginning of the year 1854, a request was made to me from the Board of Ordnance, to design and give an estimate for a complete set of machinery for manufacturing rifle muskets in their contemplated new factory at Enfield. With this request, in the comprehensive form in which it was made, I did not feel myself justified in complying. It was then proposed that I should undertake the construction of the machinery for making the rifle barrel only. Before giving an answer, I stated that I wished to visit the establishments of the principal gunmakers, and obtain from them all the information I could. I found great differences of opinion amongst the gunmakers, and the information I received was so contradictory that I was unable to come to any satisfactory conclusion. I subsequently offered to make a series of experiments in order to ascertain on what principles rifle barrels and their projectiles ought to be constructed, and to supply a single set of machinery for their manufacture, provided a gallery for shooting was erected under my directions, where I might make the necessary experiments, and obtain facts which would enable me to form a correct judgment; on these conditions I offered to give gratuitously the necessary time and attention to a subject in which, in a scientific point of view, I could not help taking great interest. The matter then remained for some time in abeyance, but was afterwards brought under the notice of the Commander-in-Chief by the late Earl of Ellesmere, who was aware of what had taken place. I received from his Lordship a letter, stating that he had had a conversation with Lord Hardinge on the subject, and that he was desirous of seeing me. The result of my interview was that, at Lord Hardinge's special request, Government resumed the consideration of my offers."

1339. On the 7th of April 1855, the superintendent of the Royal Small Arms Factory reported that Mr. Whitworth had up to that time failed to produce satisfactory machines for turning and boring rifles, and it was ordered (17th and 21st September) that the machinery requisite for the production of 250 barrels a day should be procured from America. Had you, up to that time, constructed any larger ordnance than a gun barrel?—It was on the 9th December 1855 that, at the request of Lord Hardinge, I agreed to rifle brass guns.

1340. On the 24th December 1855, there was one 6-pounder, was there not?—A 24-pounder brass howitzer was the first.

1341. Had

1341. Had you on the 24th December 1855, constructed yourself a 6-pounder gun?—No.

1342. Had you constructed a gun smaller than a 6-pounder but larger than a musket barrel. On the 24th of December it is stated here that you had received an order from the War Office for "one 6-pounder." Had you previously to that constructed a 6-pounder, or anything smaller than a 6-pounder in the shape of ordnance?—Previously to December 1855? No.

1343. On the 24th of January 1856, you were, I think, ordered to rifle one 24-pounder howitzer?—I believe there were three 24-pounder howitzers.

1344. There are two subsequently on the 18th of April, but had you, previously to that, constructed your ownself a 6-pounder howitzer?—We did not construct them; they were guns of the service, sent down to me to bore and rifle.

1345. When did you first construct a piece of ordnance?—Those were the first.

1346. They were sent down to you to be rifled, but you did not construct them?—No.

1347. When did you first construct a piece of ordnance?—The first that I constructed was the one that I mentioned just now; the segment gun.

1348. That little one which you showed the Committee?—The 20-pounder was about the same time as the small 10-inch.

1349. Had you, up to the 24th of December 1855, constructed a larger piece of ordnance than a 6-pounder?—No.

1350. But you stated just now, that you had constructed a 20-pounder in the year 1855?—I mentioned, that though the hoops were made, and the segments were made, that gun was never finished.

1351. Mr. *Vivian.*] The gun was in course of construction, was it not?—Yes.

1352. Captain *Jervis.*] I understood you to say, just now, that you had constructed a 20-pounder in 1855, on the coil principle?—It was partly finished.

1353. Sir *John Hay.*] It has never been finished?—No.

1354. Mr. *Baring.*] With regard to that very gun, I wish you would explain to the Committee exactly what you mean by the hoops of coiled iron which you used in the construction of that model, and in the partial construction of that other gun; how did you make the hoops in your process of manufactures; did you make them yourself, or do you buy them?—We had them made.

1355. Who made them?—A man of the name of Bamforth, at a forge in the neighbourhood of Manchester.

1356. Then he would be able to answer how those hoops were made?—Yes.

1357. Can you state whether you yourself, in any gun made subsequent to that time, have ever made a hoop of iron coiled round and round as has been described by one of the Honourable Members of the Committee, and welded together on the Armstrong principle?—The hoops we have used we have got always made up at the forges, the Haigh iron works, and others.

1358. In the first place you have received some guns from Woolwich in order to manufacture them, have you not?—The original hoops were ordered, and were made by simply twisting a bar of iron in a heated state around a stud or pin placed in the centre of the smithy, and there forming a coil, and afterwards getting it up to welding heat, and hammering it into a coil or hoop; that was Mr. Bamforth's plan.

1359. Mr. *Baring* (to Mr. *Hulse.*)] In respect first to the small model gun, let me ask you what was the way in which the hoops were manufactured for that gun?—In the small model gun there were instituted three experiments with a view to ascertain the best mode of constructing the hoops so as to give the greatest strength with the same quantity of metal. One mode was that of welding the hoop together diagonally, as a band of iron; the second mode was taking a riband of iron, and folding it round, and welding the ends to the body; the third plan was taking the band of iron, coiling it round spirally, and welding it endwise; then the hoops were subjected to inside pressure, so as to ascertain which would yield first; and the spirally made hoop stood the greatest pressure.

1360. Was that model constructed of hoops made from coils made from a riband of iron on the same principle as Sir William Armstrong's are now made at Woolwich?—Yes, precisely.

1361. When the 20-pounder was commenced, were you then the partner of Mr. Whitworth?—Yes.

1362. How far was that gun completed?—I should think that three-fourths of it was completed, with respect to the work, and the whole of the material.

1363. Were the hoops made for the gun?—Yes.

1364. How were they made?—Variously; those made by Mr. Bamforth were made, as explained by Mr. Whitworth, coiled spirally, for I went to Mr. Bamforth myself from Mr. Whitworth, gave directions myself, and conferred with him on the best plan for carrying them out.

1365. Mr. *Vivian.*] That was in 1855?—Yes.

1366. Mr. *Baring.*] Therefore those hoops were made, not by Mr. Whitworth, but under his directions on precisely the same principle and system as the hoops made at Woolwich?—They produced precisely the same results, but they were not made by precisely the same means.

1367. Will you explain the difference to which you point to the Committee?—The difference in means was, that at Woolwich they had a furnace 90 feet long, which we could not obtain in any manufactory then existing; they had coiling apparatus and steam hammers purposely adapted to the work; they had a large plant established, which at that time could not be had by us.

1368. In the construction of the larger guns, the 70-pounders, made under the superintendence of Mr. Whitworth afterwards, I believe it is in evidence that the hoops were sent to Mr. Whitworth from Woolwich?—No, I think not; with the exception of two guns, I do not know that any were received from Woolwich, and certainly they were not the first; and those two were larger in diameter than our manufactory could make.

1369. Were the hoops not obtained from Woolwich, but used in the manufacture of any guns by Mr. Whitworth, subsequently to this little experimental gun, always made under Mr. Whitworth's directions, precisely on the same principle?—No large gun was ever made without coiled hoops by Mr. Whitworth; nothing above 12-pounders.

1370. Those coiled hoops, I suppose, being not only iron made into a coil, but on precisely the same principle as the Armstrong coil?—On precisely the same principle as the Armstrong coil, only that the hoops were never welded to each other; the hoops made at Woolwich are turned and recessed, put into hydraulic press, and then put into a furnace and welded together; that plan was never adopted by Mr. Whitworth.

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1371. Do I understand you to say that the only difference is in the size of the hoop that you made; that in consequence of your not having a furnace sufficiently large you were enabled to make only hoops smaller in size, but which were in principle precisely the same?—There was a limit to the length of the hoop in our establishment, which was not experienced at Woolwich; but what I meant was that if they had made two hoops at Woolwich of a given length they could afterwards, with their facilities, weld them together so as to make one continuous length.

1372. Mr. *Beecroft.*] Dove-tailing them together?—Yes.

1373. Mr. *Baring.*] But the small hoop which was made under Mr. Whitworth's directions was itself made of a coil?—Yes.

1374. Mr. *Vivian.*] It was forged endwise?—It was forged endwise.

1375. Mr. *Beecroft.*] It was welded?—Yes.

1376. Mr. *Baring.*] That is to say, it was constructed of a riband of iron?—It was constructed of a bar of iron, not a riband.

1377. What size would it be?—The bar of iron would be about two inches square.

1378. And that bar was twisted round, and round, and round?—Yes, so as to make a spiral.

1379. And welded?—Yes, welded endwise.

1380. And that was the hoop?—Yes, that was the hoop.

1381. Both in the small model gun, and in the 20-pounder?—Yes, and in all subsequent guns larger than a 12-pounder.

1382. Mr. *Laird.*] The hoops in Sir William Armstrong's guns were connected longitudinally, which was not the case in Mr. Whitworth's guns?—Yes; Mr. Whitworth prefers to connect them together by a screw; the others are welded together.

1383. Mr. *Vivian.*] This 20-pounder gun was three-fourths finished on the coil system in 1855?—Yes.

1384. Mr. *Laird.*] Were those separate hoops screwed together in your original plan?—Not in the original plan, but in subsequent plans they were screwed instead of being welded.

1385. Captain *Jervis* (to Mr. *Whitworth*).] You seemed to consider, in your last examination, that the Ordnance Select Committee had stated that the polygonal system of rifling belonged to Mr. Brunel rather than yourself, and you read an extract from Mr. Brunel's letter to Mr. Westley Richards. Would you mind reading the whole of that letter?—"18, Duke-street, Westminster, November 26, 1858. My dear Sir,—I am obliged to you for your communication on the subject of the octagon gun, and in acknowledging your courtesy and gentlemanly feeling, I must add that it is only what I always felt I could rely upon from you. I beg you will not hesitate to take out a licence from Mr. Whitworth for octagon guns (if as a matter of business you think it convenient to do so), on account of any prior claim which you may know I could set up, and if you get a licence for a nominal consideration, as I understand you can, of course, as a man of business, you should do so. I have no intention of interfering with Mr. Whitworth's patent, even to indulge the feeling I have against all patents and protective laws, which I consider have become the curse of the day, and the sources of the greatest injury to inventors and manufacturers and still more to the public; and I should also be very sorry even to annoy my friend Mr. Whitworth, merely for the sake of showing that I had previously made the gun (at least, you made it for me), and I believe others have preceded me, which he has patented, and I assure you that I shall not consider your taking out a licence as in any way a denial of this fact, of which you are cognizant. I have never seen Whitworth's patent. What is it exactly that he does patent? It cannot be merely the polygon, because even if nobody had preceded me, that would have been already a copy of mine, which not only was made before he began our investigation, but was lent by me, at your request, to him, I think before his patent. My rifle is, I am told, doing quite wonders at Woolwich, and I begin to think there must be something in the principle which I intended to introduce into it, and which is totally different from what I understood to be Whitworth's. I sought to use a comparatively loose ball, but which I thought would centre itself both in position and direction to the axis of the barrel, by the peculiar action of a polygon within a polygon, acted upon by an increasing pitch, and it really seems from the results as if my theory was correct."

1386. Do you think, therefore, that the Ordnance Select Committee were prejudiced in any way in making the suggestion that Mr. Brunel had originated the thing before you did, when Mr. Brunel himself states that to be so?—Mr. Brunel states that the polygonal system was known and had been used before it had been used by him.

1387. But still you took out a patent for it?—Not precisely for the polygonal system.

1388. You make no mention of it in the provisional specification, but you got it inserted in the final sealing of the patent, did you not?—The provisional specification, I believe, is quite sufficient in its description.

1389. Did you mention the polygonal system of rifling in your provisional specification?—It is stated in the provisional specification: "Firstly, in constructing cannons, guns and the barrels of fire-arms in several parts, and uniting them by means of screws, belts or similar contrivances," and so on.

1390. Does that say anything about the polygonal system of rifling?—No; I could have shown other systems of rifling, but I took the one that I thought best.

1391. But there is a polygonal system of rifling shown in the provisional specification, is there?—It is not necessary to describe it there; it is described in the complete specification itself.

1392. Is it not obliged to be in the provisional specification?—If it had been obliged to be in that, of course the law officers would have returned it, and had it put in.

1393. Your provisional specification is dated on the 1st of December 1854, and the final specification in May 1855. You stated, on the last day of your examination before this Committee, that it was in the spring of 1855 that Mr. Westley Richards had shown you Mr. Brunel's rifle?—Yes, I think so.

1394. And it was subsequently to that, was it not, that you had the words "polygonal system of rifling" inserted in the specification?—The specification is due six months after December.

1395. Mr. *Vivian.*] Is there any claim in your patent?—Yes. "Firstly, the several combinations of parts forming (when put together) the barrels of ordnance, or fire-arms having a polygonal spiral shape; secondly, the use of the spirally shaped segments; thirdly, the adoption of the polygonal spiral for rifled ordnance and fire-arms; fourthly,

fourthly, the combination of parts forming the breech-loading apparatus, but all as described previously in the specification.

1396. Captain *Jervis.*] Mr. Brunel seems to be under the impression, from his letter, that the polygonal system of rifling was inserted in the specification after your having seen his rifle?—I cannot say; but the idea I had at the time was, that large guns were very much wanted, and knowing how difficult it was to deal with cast iron, I considered it desirable to make them in segments to get over that difficulty, and this polygonal system, as you will perceive, does better than any other system where the interior would be made of segments.

1397. I merely wanted to show that the Ordnance Select Committee were supported by Mr. Brunel himself, and that he had made arms of that nature previously to your taking out your patent?—Yes; he ordered one to be made by Mr. Richards, which differed from mine, as I have pointed out.

1398. Mr. *Vivian.*] Do you desire in your patent to claim the system of polygonal rifling as your own invention?—Only in connection with the spiral segments as described.

1399. Captain *Jervis.*] You only claim it in the sense that your gun is made of several pieces together, the barrels having a polygonal spiral shape?—Yes.

1400. Then how do you read the following:—"Thirdly, the adoption of the polygonal spiral for rifled ordnance and fire-arms"?—The patent was taken out thus: "Firstly, in constructing cannons, guns and the barrels of fire-arms in several separate parts."

1401. Then do you read the other two sentences of your claim as likewise connected with the gun being made of several separate parts; do you not also claim that apart from the other?—It is so claimed here.

1402. Therefore you did not take out the patent for the polygonal spiral as a matter by itself?—In connection with other things.

1403. Is it to be read in connection with the weapon being made in several pieces, or not?—I took out the patent for the things there described.

1404. But is not the way in which I read it the way in which it reads to your mind?—No.

1405. Are the Committee clearly to understand that you did not propose to patent this polygonal spiral as a matter by itself?—I patented it in connection with other parts, as shown in the specification.

1406. The gun must be made of pieces, otherwise you do not claim it; is that so?—It is claimed as described in the specification.

1407. Well, then, as described in the specification, it is the one which Mr. Brunel gives us to infer that you obtained the idea from a gun which he had ordered to be made by Mr. Westley Richards, and which was shown to you?—I can myself distinctly say that I had no idea of Mr. Brunel ever having had anything to do with making a polygonal rifle, when I constructed this segmented polygonal rifle.

1408. In the provisional specification of the 1st of December 1854, you took no notice of the polygonal spiral; you say, that in the spring of 1855, Mr. Westley Richards did show you this gun of Mr. Brunel's, and then your specification is taken out at the end of the spring of 1855, in which you inserted the polygonal spiral; did not Mr. Brunel consider that you had obtained that idea from the gun that he had constructed, although it had been done long before his time?—I do not think that Mr. Brunel ever said that; I state most distinctly, that I had no knowledge of what Mr. Brunel had done, and Mr. Westley Richards, in his correspondence with me, did all that he could to prevent my pursuing the polygonal system, saying, that although this rifle of Mr. Brunel's had shot well, the second that he made was a complete failure.

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1409. Then Mr. Westley Richards did bring it to your notice?—He brought it to the gallery.

1410. You had seen it before you took out your patent, had you not?—No; how long time after I do not know; when I constructed this rifle on the polygonal system, with a segmental barrel, I had no knowledge whatever of Mr. Brunel's rifle; I state that most distinctly, and Mr. Westley Richards did all he could to persuade me not to go on with the polygonal system.

1411. You wrote to this Committee last year, "I should be glad if my evidence could be taken before the Committee separate, as allusions have been made to myself and my system of rifled artillery, in evidence given before the Committee, which will convey a wrong impression unless explained; for example, I would refer to the statement of Colonel Lefroy, that I had been paid 2,080 *l.* for experiments in ordnance, which is incorrect; the fact being, that I have not received anything from Government for experimental purposes connected with ordnance; the whole cost of which (amounting to many thousand pounds) has been defrayed entirely by myself;" do you still wish to maintain that?—Yes.

1412. There was a return given to this Committee, pointing out, that you had received something like 29,000 *l.* as payment of your different expenses, nearly half of which was for ordnance; will you kindly look at this paper here with your different accounts, in which you make the various claims for amounts which you have expended, and which are stated by the War Office to have been paid?—I can state it better from my own books.

1413. You do not wish to dispute this account sent in from the Accountant General's?—By no means; but a great deal depends on the form in which the accounts are put. I will make a statement from my own books, "Amount received by Mr. Whitworth from Government, and amount expended by Mr. Whitworth on his own account up to the 31st of March 1863:—Amount received for rifle experiments, 15,895 *l.* 1 *s.* 2 *d.*, including the cost of the gallery, which was 5,707 *l.* Amount received for large ordnance, (no experiments) 4,735 *l.* 8 *s.* 1 *d.*, the total being 20,630 *l.* 9 *s.* 3 *d.* Mr. Whitworth's own expenses 10,482 *l.* 19 *s.* 5 *d.*; that is exclusive of all personal expenses.

1414. Will you be good enough to look at the account which you sent into the War Office, and see whether you have not charged for every item including gas, taxes, and every small detail which could possibly have been incurred?—The charges for gas would be for the gas in the gallery.

1415. I merely ask you whether you have not put in the very smallest items that could possibly have been incurred?—For the rifle experiments they are all included. The expenses of the gallery would include the gas; but for my own expenses not a shilling has been charged since 1855, when I commenced the experiments.

1416. What do you call your own expenses?—Personal expenses, travelling expenses.

1417. But the question is, do you object to Colonel Lefroy's statement that you had received payment

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payment for your expenditure in ordnance; you say that you have never received a penny?—Yes, exactly, and I am prepared to maintain that statement.

1418. Then that account from the War Department is incorrect with regard to your having received payment for all the accounts of expenditure which you sent in?—This is the first time I have seen it; the accounts would require to be analysed, but I have no doubt that the items must come out the same as I have got them.

1419. Perhaps you will consider that point, and let me have an answer to the question the next time the Committee sits?—I will do so.

1420. Mr. *Vivian.*] I understand from you that you have received sums of money on account of ordnance actually made or rifled, and delivered to the Government, but not on account of your ordnance experiments, that is the distinction you draw?—Yes, we have been paid for the experiments with rifles, but for the ordnance we have been paid for no experiments; we have simply been paid for work done.

1421. Captain *Jervis.*] But were not the whole of the experiments in your small arms, in the course of your experiments towards your big guns?—The experience that I had with the rifle, and my success led me, at the request of Lord Hardinge, to rifle the artillery. This, which I hold in my hand, is the report of the special committee appointed to inquire into Mr. Whitworth's expenditure on account of experiments on behalf of Her Majesty's Government. Colonel Hutchinson was the president, and Captain Warlow and Mr. Anderson made an examination of the books, and they say, "Before terminating the report, the committee wish to state that their labours at Manchester were much lessened by Mr. Whitworth's zealous assistance, who appeared most anxious that they should sift to the bottom every pecuniary transaction, and they beg leave to express their conviction, that he has only charged to Government the expenses he has himself incurred and discharged." They say here also, "The committee would suggest that experiments should be made. First, in the qualities of different sorts of powder, tested by comparative elevation. Second, in the results obtained by different turns of spirals in barrels. Third, in the effects produced by different lengths of projectiles, and by different lengths of barrels. Fourth, in penetration through metal plates. Fifth, in trajectories through screens placed at intervals. The cost of fully carrying out these experiments would probably be between 5,000*l.* and 6,000*l.*; but it is reasonable to expect that they will finally set at rest many important questions still pending. These experiments will also be most valuable as aids in solving various points on the subject of projectiles for heavy ordnance. As the past experiments have been conducted with great ability, and at a sacrifice of much time and money, it seems to the committee that it would be most unadvisable to stop them at a moment when a comparatively small further outlay would enable them to be brought to a satisfactory conclusion."

1422. I think the result of that committee was that the accounts which you sent in were liquidated by the Treasury?—Yes; the accounts did not include anything relating to rifled artillery.

1423. Sir *John Hay.*] Do you mean to say that the Government have fairly paid you as a manufacturer, but not as a man of science?—Yes; the Government paid for the guns and projectiles I supplied, not for my expenses in making experiments to produce them.

1424. Mr. *Vivian.*] I understand you to say that the balance expended on experiments for large guns stands now against you to the extent of upwards of 10,400*l.*?—£.10,482. I am that much out of pocket.

1425. Captain *Jervis.*] You claim that from the Government, do you?—I do not claim that. I have received 15,885*l.* for experiments connected with rifled barrels, and 4,735*l.* for the ordnance which has been supplied by me as a manufacturer.

1426. Mr. *Vivian.*] For actual work done?—For actual work done.

1427. Sir *John Hay.*] But in addition to that, the company with which you are connected, have charged you with 10,482*l.* for experiments, for which you have not been reimbursed?—Precisely.

1428. Mr. *Vivian.*] On large ordnance accounts you have received nothing, except for work done; nothing for experiments?—Yes, just so.

1429. Captain *Jervis.*] The return gives 10,278*l.* paid you for ordnance. Is that correct?—That includes, no doubt, the work done by the Government themselves.

1430. Is not this very expenditure on ordnance actually an expenditure to enable you to carry on a series of experiments with your own guns?—I made some of the experiments with those guns.

1431. Were the expenses not incurred for experimental purposes?—Yes.

1432. Therefore you receive that 10,000*l.* as it were, as a payment towards the experiments?—No. All that I have received has been, as I have stated, 4,735*l.*

1433. But they say here, that the expenditure on ordnance is 10,278*l.*; was not that actually for experiments?—That amount must include guns that have been made on my plan at Woolwich.

1434. But for experiments for your system?—Yes, I have no doubt of it.

1435. Mr. *Laird.*] The result of the whole is this, that taking the cost of all the experiments, you are 10,482*l.* out of pocket?—Yes.

1436. Mr. *Baring.*] Is the committee to understand that you think that in equity and fairness you ought to be paid a larger sum by the Government for the experiments?—I have sent in no account.

1437. But is it your feeling that you ought to be paid?—I have made no claim.

1438. Sir *John Hay.*] Is it not the case that of course these experiments have so far benefited you, that they have enabled you as a manufacturer to produce guns, some of which have been sold to foreign countries, which would not have been so perfect as they are now, had it not been for this expenditure?—I had not the most distant idea of turning manufacturer of rifled guns. I took it up solely because I was requested by the Government, but when I received a letter from General Peel, that no more experiments were to be made with guns on my principle, I determined at once to become a manufacturer, and prove that what I have done was right with respect to rifles and ordnance. With respect to the rifle, it is proved that I was right; and I think it will soon be admitted that I was right with respect to ordnance.

1439. But still you have had so far collaterally some remuneration for those experiments?—I have not the least doubt that it will be all repaid in time.

1440. Mr. *Beecroft.*] Were any of those experiments

riments at your own expense made at the request of the Government?—They were commenced most certainly at the request of the Government, and were so up to the time that I received the letter from General Peel.

1441. But you received no money?—None, except for work actually done.

1442. And delivered?—And delivered.

1443. *Chairman.*] Were you not specially requested by Lord Hardinge to proceed continuously with those experiments as rapidly as possible for the sake of the Government, and not for your own sake?—Yes.

1444. And that extended over many months, and he was continuously urging you on?—Yes, he used to come down himself.

1445. Captain *Jervis.*] The whole of that portion of the experiments have been paid by the Government, have they not?—Those that I have mentioned have been paid for.

1446. Sir *John Hay.*] Can you refer the Committee to any guns built up of welded coiled hoops before Sir William Armstrong introduced his rifled ordnance?—

1447. Do you not consider, in availing yourself of the experience of the coiled system used by Mr. Anderson at Woolwich for the manufacture of your 7-inch gun, that you had, in fact, the benefit of Sir William Armstrong's labour and experience up to that date?—I feel that I am very much indebted to Mr. Anderson for the able manner in which he has carried out the manufacture of my gun.

1448. Mr. Anderson is at this moment a subordinate of Sir William Armstrong?—Certainly. I never saw Sir William Armstrong at Woolwich while the gun was being made.

1449. But the system was his system, and conducted under his orders in the Royal Gun Factory?—Yes.

1450. And your gun was made under his subordinates?—Precisely.

1451. Mr. *Vivian.*] Do you think Sir William Armstrong's principle of manufacture is right or wrong?—I believe it is utterly wrong.

1452. Sir *John Hay.*] Then why did you avail yourself of it?—Because I was desirous to show that I could send a shell through armour plates, and there was no other way in which I could get a gun made with a 7-inch bore weighing seven tons except at Woolwich. I am convinced that no large gun made of welded iron will stand. I utterly condemn welded iron in a gun at all, either for the inner tube or for the coil.

1453. Sir *John Hay.*] But up to this date, I gather from your answers, that your theoretical plan of making a gun has not yet been carried out into practice, and therefore you were obliged to avail yourself of the best plan?—Yes, I have now carried it out; I had not at that time.

1454. But up to the date at which you availed yourself of the Woolwich Royal Gun Factory to make the 7-inch bore guns, there was no system so perfect for making a large gun as Sir William Armstrong's system, was there?—I go with Krupp, of Essen, the manufacturer of homogenous metal; I think we are more indebted to Krupp than to anybody.

1455. But at the date of your 7-inch gun being made, you availed yourself of the Woolwich Royal Gun Factory, believing it to be the only manufactory in this country at which it could be made?—Yes.

1456. Therefore, up to that date, Sir William Armstrong's system was the best for a gun of that size?—It was because they had the machinery for the manufacture.

1457. Mr. *Vivian.*] The country, at great expense, had established a large factory for the carrying out of that particular system of making large guns?—Yes.

1458. There was no other factory for the manufacture of large guns in the kingdom capable of making a gun sufficiently strong?—Except the works of Mr. Clay, at Liverpool; he had made guns as large as they had been made at Woolwich, but he had not the same facilities; but I disapprove of Mr. Clay's system also, and of all systems that include the use of welded wrought iron.

1459. In fact, you desired that your system of rifling should be tried against armour plates, and the only means by which you could accomplish that object was by obtaining from the Government the services of their gun factory for the making of the gun?—I had a notion that I could make a shell that would pierce an armour plate, and that would burst inside the ship; and I was very anxious to get a gun made big enough.

1460. Sir *John Hay.*] And you succeeded?—Yes, and I succeeded.

1461. Mr. *Dodson.*] Have you up to this time got a large gun made on your own design, in your own way?—Yes.

1462. Has that been tried?—Yes; we are now regularly manufacturing them on that plan; the coils and inside tube being made of mild steel or as it is sometimes called homogeneous metal.

1463. What gun is that which you refer to?—A 5½-inch bore gun, of the same size as went through the 4½-inch armour plate, at 600 yards distance.

1464. Is that the only gun hitherto made in your own way?—We have 12-pounders of metal like the one at Shoeburyness. I should never think of building up a 6-pounder, or a 12-pounder; it seems to me almost as absurd as trying to build up a rifle.

1465. How many of those 5½-inch bore guns have you made?—Upwards of 30.

1466. Mr. *Beecroft.*] Colonel St. George stated in his evidence, that you have found that homogeneous iron does not answer for large guns, and that you now had them made on the coil principle in the Royal Gun Factory; is that correct?—No, that was a mistake of his.

1467. You also employ the same material for your projectiles intended for penetration?—Yes.

1468. Are you still of opinion that the flat front is the best form for penetration?—Yes, undoubtedly; especially at an angle; it is the only one that will do.

1469. *Chairman* (to Mr. *Hulse*).] Did you have any communication with Mr. Anderson relative to the drawings of Mr. Whitworth's 7-inch gun, and did you make any suggestion on it?—Yes; all the letters and communications were referred to me, and I had also an interview with Mr. Anderson at Woolwich on the subject.

1470. Will you state to the committee what passed between yourself and Mr. Anderson on the subject at Woolwich?—I may explain that previously to that interview Mr. Whitworth had also been in communication with Mr. Anderson, and had submitted this drawing (*referring to drawing* W.) Also, previously to my visit, we received these two drawings, W. 68 and W. 69. Mr. Whitworth was then unwell, and wished me to go. I may explain from Mr. Anderson's letter at first, that in sending these tracings he stated a preference for W. 68, as it had a closed breech. At my

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my interview I pointed out the objection which Mr. Whitworth and I had to this enormous mass at the breech, and that it would be preferable to have a more equal distribution of the metal, as shown in the original drawing W.; also, that the mass of metal about the trunnion was objectionable. But the preference was given to the screw in the breech, as is shown in W. 69, and which was the same as had been used in the 70-pounder gun on Mr. Whitworth's principle in the year before; that therefore the combination of the two drawings would be preferable to either. I also pointed out that the weight of these two guns would be less than the weight of the guns shown in Mr. Whitworth's drawing W., on account of the lesser specific gravity of their metal, and I sketched in pencil, on a W. 68, and the pencil marks remain, the mode of overcoming the reduced weight by adding the hoop outside. The outline of drawings W. 68 and W. 69 is precisely the same, or as nearly as possible the same, as the original drawing of Mr. Whitworth's. The diameter is the same, the lengths are the same, and the only difference is in the weight.

1471. Was that all that passed between you and Mr. Anderson?—No, there also passed between us the question of uniting the hoops together. In the drawing furnished by Mr. Whitworth, they are shown screwed together, and are of homogeneous metal, instead of wrought iron. The practice which was then and which is still adopted at Woolwich, was that of boring and turning the ends of the hoops, and afterwards welding them together, instead of screwing them. That was one of the details of construction which were left with Mr. Anderson. He pointed out the difficulty which they would have in following out our process of manufacture. He would have done that if we had insisted upon it, but he naturally preferred to carry out that plan which was most inexpensive, and which came readiest for him to do.

1472. In what respects did the actual drawing according to which the gun was made, agree with the original drawing of Mr. Whitworth?—This (*pointing to a drawing* W. *before the Committee*), is the original drawing furnished by Mr. Whitworth; and this W. 87, to which I am now pointing, is the drawing of the Royal Gun Factory. They are alike, of course, in calibre, and they are alike in length. The greatest difference is in the breech. They are alike also in the thicknesses; that is to say, the tube is nearly the same, and there is a uniform distribution of the metal. In the drawing of the Royal Gun Factory, there is a hoop outside, which is put on in order to make up the weight. That hoop does not appear in Mr. Whitworth's original drawing; if it had done so, it would have made the gun too heavy.

1473. Can you state why Mr. Anderson offered to undertake the responsibility of the details of construction of Mr. Whitworth's gun?—Because, in the first place, Mr. Whitworth shrank, and very properly shrank, from the responsibility of this great mass of metal, (*pointing to drawing* W. 87), feeling that if ever that gun does go, it will be there. That was one point of the responsibility, another was the mode of closing the breech. The details of the construction appertain to the closing of the breech in this peculiar way, instead of its being screwed in the other way. There was also the mode of shrinking on the hoops, and the amount of allowance for shrinking. In the one drawing, the tube is cylindrical from end to end, and the allowance has to be made for shrinking; while in the other a positive and definite allowance is given for shrinkage or pressure, by making the inner tube and hoops taper (say) one in a hundred, and forcing the hoops on by hydraulic pressure.

1474. In what respects do you consider the gun made at Woolwich for Mr. Whitworth differs from the gun known as the Armstrong gun?—It differs first of all in its weight, the one being four tons, and the other being seven tons; it differs in outline; in fact the guns differ as much as it is possible for two guns to differ—here (*referring to the drawing*) is the outline of an Armstrong gun of the same calibre shown red, immediately over that is the Whitworth gun, and beyond that in blue lines the gun is shown as it actually was made; the red lines show a much greater difference than exists between the black lines and the blue lines. The two guns differed both in material, and in the mode of making the inner tube, and also in the distribution of the metal.

1475. Sir *John Hay*.] What the Committee want to know is, whether, in the mode of construction adopted at Woolwich by Mr. Anderson for the making of the seven ton gun for Mr. Whitworth, Mr. Anderson adopted Mr. Whitworth's principle of manufacture, or the Armstrong principle of manufacture?—As far as concerns the means adopted of making the hoops, no doubt the Armstrong principle was adopted; but there was a divergence in having the inner tube made out of the solid. In the Armstrong system it has always been on the principle of coiling, at least Sir William says a solid tube is contrary to his principle.

1476. Is that tube the tube that was suggested by you for the Whitworth Ordnance Company to Mr. Anderson for the manufacture of that gun?—No, the suggestion for closing this end of the tube arose from Mr. Anderson, and was the means of escape from this (to him) more difficult mode of screwing the breech into the barrel; it was merely a means of overcoming the difficulty of the exposed chamber-joint which is shown in the drawing W 69. Mr. Anderson felt a preference for the closed breech over the open one in which the joint was exposed to the action of the powder.

1477. Mr. Anderson preferred the closed breech, did he?—Yes; and I agreed with that preference, but I proposed to have the screw behind the closed barrel.

1478. But as a manufacturer do you not consider there is a great difference between a gun manufactured with a closed tube, and one which is manufactured with an open tube?—I consider as a manufacturer, that the open tube with screwed breech is very greatly superior to the other; but that if there is a difficulty in making the triple screw the plan adopted is the best compromise.

1479. But apart from the question which is the best, or the worst, the construction is not the same?—It is not the same in detail; and that is one of the details which we left to Mr. Anderson.

1480. But looking at those two guns, it appears that one of them is made in twenty-four parts, and the other in twelve parts; is not that an essential difference in construction?—A difference in detail only; the hoops are welded together instead of being screwed together. I consider that when the weight of a gun, its length, its diameter, and its materials are fixed, those elements determine the gun. And if the material is to be determined by another person, then clearly

clearly the mode of uniting and putting together must follow from that other person.

1481. Then it follows, does it not, that if a gun of the same weight and construction were made of cast iron, it would be the same gun as a gun made of homogeneous iron, or wrought iron?—It would have been equally acceptable if it had stood the same weight of powder and of shot as Mr. Whitworth fixed upon—namely, 25lbs. of powder, and a shot of 150lbs.

1482. Then do you mean to express an opinion that the material and the mode of construction are of no consequence so long as that point remains the same?—We think it of great consequence; but the responsibility of the material, and the putting together being taken by another, did not deprive Mr. Whitworth of the credit of being the architect of that gun.

1483. But though a ship built of wood, and another ship built of iron, may both arrive at the same results, is not the architect of a wooden ship entitled to some credit in putting the ship together, if the lines are given by an iron shipbuilder who knows nothing of wooden shipbuilding?—I would rather not answer that question; but I would say this, that I should consider that the late Sir Charles Barry would have been as much the architect of the building in which I am now speaking, if the building had been made of brick instead of stone, however the pieces were united together.

1484. But the two buildings would be of a different construction, would they not?—The details of construction would differ, and only the details.

1485. Colonel *Dunne.*] The configuration would be the same?—The configuration would be the same.

1486. Captain *Jervis.*] Did not the merit of Sir Charles Barry, as the architect of this building, consist in the peculiar formation which he gave to it, in order to the filling of a certain cubical space?—Yes.

1487. Mr. *Vivian.*] And is not that so in the case of the Whitworth gun; has he not so designed that 7-inch bore gun that it is as different from the 7-inch Armstrong gun as the House in which we are now sitting is from that which preceded it?—Yes; and I should consider even more so. I would also say with respect to the number of hoops which are alleged to be more numerous in Mr. Whitworth's drawings, that if in W 87 they were shown as they were before they were turned and united together, it would be seen that they were almost as numerous; but it is the system adopted of turning and recessing, and forcing one into another, and afterwards welding them, that produces the appearance of a single hoop.

1488. Sir *John Hay.*] What is the system at Woolwich in that respect?—The system is to forge moderately short hoops; then turn the end of one, and recess it, then turn the end of another, and leave a corresponding projection; then take them to the press and press them together forcibly, then remove them into the furnace, and get them up to welding heat, and force them together by screw pressure.

1489. By whom is that system invented?—I suppose by Mr. Anderson.

1490. Was he the Superintendent of the Royal Gun Factory at that time?—He was the assistant superintendent.

1491. Who was the superintendent?—Sir William Armstrong.

1492. Colonel *Dunne.*] And this gun made in that way you accept as Mr. Whitworth's gun?—Yes, as it was made to his outlines, with his weight of metal, and embodied his and my suggestions.

1493. The results obtained from that gun would be the results that you would expect to obtain from a Whitworth gun?—Yes; but I should expect that in another twelve months the gun as made would not give the results that the other gun as originally designed would.

1494. That is a question of endurance?—That is a question of endurance.

1495. But as long as the gun endured, you would consider the results to be fairly the results of a Whitworth gun?—Yes.

1496. Captain *Jervis.*] I should like to know from you whether, as a practical and professional man, with your evidence going before the public, and these drawings going before the public, you stand to it, that the two drawings do not differ either in outline or in principle?—I should undoubtedly, and without the slightest reservation whatever say, that the gun, although made immediately by this drawing, is a gun made according to the original drawing which was supplied by Mr. Whitworth; and I say that, as a practical engineer of twenty-seven years' experience.

1497. You say, as an engineer, that you consider there is no essential difference in the details or in the principle?—In the details there is a difference, and that difference is brought about by the peculiar mode of manufacture adopted at Woolwich, which made them unable to follow out what was a better system.

1498. And you state to the Committee, that in the construction of the bore as it stands with that breech, there is no difference in principle, nor is there any difference in that outline in respect of the strengthening by the extra coil?—There is no difference whatever in principle in the addition of the hoop; there is a difference of detail in closing the breech, but I cannot say that that alters the principle of construction; there is a difference in the plan of construction in adopting the application of heat for the purposes of shrinking on the hoops.

1499. You think that the action of the gunpowder would be precisely the same in both guns?—Except with regard to this four-inch mass, which I think will allow an enlargement to take place at that spot, which will in time become detrimental to the gun.

1500. But do you think that the effect of the gunpowder would probably be the same in both cases?—Do you mean the effect on the projectile?

1501. No, I mean the effect on the gun itself?—Yes, on the gun itself, with the exception of the part I have mentioned.

1502. Therefore, must not the two guns be distinctly different in the principle of construction?—No, there is a difference of construction in the distribution of the metal, and that difference led to the proffer of Mr. Anderson to take the responsibility, which proffer Mr. Whitworth accepted.

1503. Colonel *Dunne.*] Do you think Mr. Whitworth was fully justified in saying, as he did in that letter to the "Times," that the gun produced at Woolwich was the gun which he intended by his drawing?—I do, undoubtedly think so.

1504. Mr. *Vivian.*] By whom was that outside coil suggested?—By myself.

1505. Then the only difference in the section of the gun arises from a suggestion of your own which you made when you found that from the use

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use of metal of a less specific gravity it would become necessary to increase the weight of the gun?—Yes.

1506. Captain *Jervis.*] I understand you to state that that exterior coil arose from a proposal of your own?—Yes, I said I drew it in pencil, and I pointed out my marks on the original drawing.

1507. Then allow me to read to you the letter of Mr. Anderson's, dated the 31st of December 1861: "With reference to your letter, dated the 26th instant, I beg to inclose a tracing, No. $\frac{W}{87}$, showing the 7-inch muzzle-loading gun slightly altered in the exterior diameter at breech. With respect, however, to the removal of the outside coil, I am of opinion that this coil is indispensable to the strength of a gun constructed on the plan proposed; and with regard to the welding of the series of hoops under the exterior coil, these hoops are of a much larger diameter than we have yet done, and I am unwilling to run any risk with this gun." Mr. Anderson in that letter taking credit to himself for the proposal, do you state that you think he is wrong?—I do not read the letter in that way. The drawing alluded to there by Mr, Anderson is $\frac{W}{82}$.

1508. Let me also read to you an extract from a letter from your firm to Mr. Anderson, dated the 26th of December 1861: "Considering that the mode of construction which Mr. Whitworth would have preferred, and which we have explained to you, cannot, with the facilities now existing at Woolwich, be conveniently carried out, we will avail ourselves of your offer to undertake the responsibility, and to leave the details of construction entirely to yourself. We may, however, ask you to consider the propriety of omitting the outside hoop shown on tracing $\frac{W}{82}$, and welding the next series of hoops together so as to avoid the joints"?—Yes; I explain that in this way, that W 82 had become so much larger than W 70, and so much heavier than the weight fixed by Mr. Whitworth, that we suggested at once the propriety of omitting the hoop of that thickness, but still keeping the weight of the gun to what was originally fixed.

1509. But was not the proposal to retain that coil Mr. Anderson's proposal, while your firm wished it to be done away with?—The explanation which I have given would carry with it, I think, a different construction. It would not have mattered to us if the coil had been abandoned so long as the weight of the gun had been maintained, but we wanted the size of the coil reduced, and it was subsequently reduced from $2\frac{1}{2}$ inches to two inches, as will be seen in W 87, which was the adopted drawing.

1510. Mr. *Vivian.*] It was actually reduced?—It was actually reduced.

1511. Sir *John Hay.*] But still the coil was the suggestion of Mr. Anderson, was it not?—It was my own suggestion in the first instance; but on account of its thickness, as shown in W 82, we wished to have the gun reduced in weight. It appeared to be more than eight tons weight; and the gun, as made according to the drawing ultimately adopted, is of the required weight, the thickness of that coil having been reduced from $2\frac{1}{2}$ to two inches.

1512. Mr. *Vivian.*] Are those which you have before you the original tracings which you had in your possession at that time?—Yes.

1513. I observe pencil marks on them. By whom were those pencil marks made?—Those are the pencil marks made by myself, on the occasion of my visit to Mr. Anderson on the 23d of December.

1514. Was that the original suggestion of the hoop you are now speaking of?—That was the original suggestion of the hoop.

1515. Captain *Jervis.*] Then how do you account for the suggestion from your firm to leave out that very coil?—It was merely to reduce the weight of the gun. The wording of that letter is perhaps a little bit questionable, but the real wish indicated was, that the gun should be reduced in weight to what Mr. Whitworth had originally fixed, and the weight was reduced accordingly, showing that Mr. Anderson so understood the subject; and Mr. Anderson was quite right in retaining what I originally suggested, if even our letter seemed to express a wish for the thick coil being omitted.

1516. Mr. *Vivian.*] In Report No. 5 of the Ordnance Select Committee, which has been presented to us, it is stated in reference to this question, "that the metal is not differently distributed from that of the service gun, and that the form is not different in any degree worth notice." Now, was the Ordnance Select Committee justified in undertaking the responsibility of making a statement of that kind to the War Office; is that the fact, or is it not the fact?—It is not the fact; there is as distinctive a difference as is well possible to conceive, both in the distribution of the metal, and in the form of the gun between the Whitworth 7-inch gun and the service 7-inch gun.

1517. What is the weight of the ordinary service Armstrong 7-inch gun?—Four tons.

1518. And what is the weight of the gun designed by Mr. Whitworth, and made from his designs?—Seven tons.

1519. Is it possible to put seven tons of metal into the same space as four tons of metal?—No.

1520. Mr. *Baring.*] But is it possible to distribute the metal in the same proportion?—It is possible to distribute the metal in the same proportion, provided the calibre be reduced proportionately, but not with the same calibre.

1521. Captain *Jervis.*] What was the weight of the shot to be used with a 7-inch gun?—I do not know that that was thoroughly fixed beyond that the gun was to be of the calibre for 150 lb. shot.

1522. What was to be the charge of powder?—One-sixth, or 25 lbs.

1523. Would it not be much safer to fire that out of a 7-ton gun, than out of a 4-ton gun?—You must bring the powder charge to the measure and strength of the gun.

1524. Mr. *Vivian.*] Is it not the fact, that the gun designed by Sir William Armstrong, and in use in the service, is too light for its calibre?—Very much too light.

1525. Sir *John Hay.*] In whose opinion was the gun designed by Sir William Armstrong too light; was it in the opinion of the Government officers?—In Mr. Whitworth's opinion, and my own opinion it certainly was.

1526. *Chairman.*] Did not Mr. Anderson say, that he considered it too light?—Yes.

1527. And Mr. Anderson is a Government officer?—Yes.

1528. Sir *John Hay.*] But he was speaking, was he not, of the sealed pattern gun for the service; did you allude to the service of a 100-pounder?—Yes.

1529. And you say that is too light for the purpose for which it is intended?—Yes; for penetrating

penetrating armour-plates, it would be totally incompetent.

1530. When that gun was adopted by the Government, were iron-plates adopted?—But that 4-ton gun has been continued since.

1531. At the time, however, when it was first introduced, was it required for that purpose?—I am not prepared to say, but it has been continued since, and I have not heard that any difference of opinion now exists. I mean a difference of opinion at Woolwich.

1532. At Woolwich and at the War Office, they are satisfied with that gun, you think?—I do not know.

1533. Mr. *Baring.*] You have instituted a comparison between the 7-inch gun which we have been discussing, and the 7-inch 100-pounder service gun?—Yes.

1534. And what is the charge for the service gun?—$\frac{1}{8}$th or 12½. In the 7-inch gun it would be 25 lbs.

1535. And do you think that, with respect to guns of the same calibre, there can be any fair comparison, when the amount of metal used is in one case in order to resist 14 lbs. of powder with a 100 lb. shot, while in the other case it is 26 lbs. of powder with a 150 lb. shot?—I say this, that I should consider that a gun ought to be able to stand all the powder it can consume. A gun of any given calibre whatever can only consume a certain quantity of powder, and any more powder added to that will produce no greater effect, either in propelling the projectile or in any other way.

1536. My question has reference entirely to the comparison you have drawn between the Armstrong 100-pounder and this 7-inch gun. What I ask is, whether any comparison can be instituted between two guns assumed to be of the same calibre, if one is made to stand a charge of 14 lbs. of powder with a 100 lb. shot, while the other is made to stand a charge of 26 lbs. of powder with the 150 lb. shot?—A comparison can be instituted between the guns with respect to the uniformity or otherwise of the distribution of the metal, and in respect to the mode of the construction of the gun, and that can be done just the same whether the gun is to weigh four tons or seven tons.

1537. You have produced a drawing showing that the 100-pounder of Sir William Armstrong was very much smaller in its dimensions than the 7-inch gun of Mr. Whitworth?—Yes.

1538. Would Mr. Whitworth have constructed a gun which was only to stand a charge of 14 lbs. of powder of the size of that 7-inch gun which is made to stand a charge of 26 lbs. of powder?—Not of the same size, but on the same principle of construction.

1539. Will you be kind enough to explain what you mean by "principle of construction"?—I mean as to the equal distribution of the metal.

1540. Then will you be so good as further to explain what you mean by the term "equal distribution of the metal"?—The meaning of the term "equal distribution of the metal" is the equal thicknesses of the series of hoops and tubes; the unequal distribution of the metal consists in the assemblage of great thicknesses at one part or another.

1541. Do you mean that the 7-inch gun, which has been constructed at Woolwich, is made upon a different principle, as far as the equal or unequal distribution of the metal is concerned, from the ordinary Armstrong gun with a 9-pounder, 12-pounder, or 100-pounder?—The Whitworth gun is made with a much more equal distribution of the metal than any guns previously made at Woolwich that I am aware of.

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1542. Will you kindly point out the difference?—If I had a section of the Armstrong 7-inch gun, I could do it better; but there must be an unequal distribution of the metal corresponding with the inequalities shown outside the powder chamber (*referring to a drawing*).

1543. Then, I am to understand you to say, that you can make no comparison between the size and weight of metal of guns that are formed to stand very different charges of powder?—A comparison may be made between two guns constructed upon the same principles; that is to say, as far as equal or unequal distribution of the metal is concerned, whether the gun be intended for the consumption of 12 lbs. of powder, or 25 lbs. of powder.

1544. But not with respect to size?—Not in magnitude; but it can never be considered necessary to have guns made that would not stand the powder that can be consumed in them.

1545. And therefore the diagram which you produce there, showing the 100-pounder gun, inside the other 7-inch gun, has no reference whatever to the argument?—Yes, it has, inasmuch as the bore is the same; it is to project a shot of 120 to 150lbs., and a shot of that weight in proportion to the calibre, will produce the greatest effects in all respects that the gun could produce.

1546. Then it is not the weight of the shot, or the diameter of the bore to which the real calibre applies, but simply the quantity of powder which the gun can stand?—They are all bound together; the weight of the gun, the charge of the powder, the diameter of the shot, the length of the shot, and the weight and length of the gun in relation to its calibre; they are all bound up together as elements concurring to produce the maximum effect; and I believe them to be carried out to produce the maximum effect in the Whitworth 7-inch gun, in that calibre in that length, and in that weight of gun in that metal, and weight of shot and charge of powder.

1547. Then you do think that a fair comparison with respect to the weight of metal in the gun is to be made between a gun which is formed to stand a charge of 14 lbs. of powder, and a gun which is formed to stand a charge of 26 lbs. of powder?—I would put it in this way, that a fair comparison is to be made between a gun constructed in one way of a given calibre, and a gun constructed in another way of the same calibre.

1548. What do you mean by "calibre?"—Bore.

1549. You mean that the weight of the gun depends not upon the quantity of the powder, but that the strength of the gun, whether it should have a greater quantity of metal opposite the powder chamber, or a smaller quantity of metal depends entirely upon the size of the bore, and not on the charge of powder?—I think the bore determines the quantity of powder, determines the weight of the shot, and determines the weight of the gun, and determines the length of the gun required to produce the maximum effect.

1550. How can the bore determine the quantity of powder?—It determines the qaantity that can be consumed; if we put 40 lbs. of powder into a 7-inch bore, we should get no greater result than we should from 26 lbs. of powder.

Lunæ, 27° die Aprilis, 1863.

MEMBERS PRESENT.

Mr. Baring.	Captain Jervis.
Mr. Beecroft.	Mr. Laird.
Lord Robert Cecil.	Mr. Monsell.
Mr. Dodson.	Sir Morton Peto.
Colonel Dunne.	Sir Frederic Smith.
Marquis of Hartington.	Mr Vivian.

The Right Hon. W. MONSELL, in the Chair.

Captain Cowper Coles, R.N., called in; and Examined.

Captain *C. Coles*, R.N.

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1551. You are a Captain in the Royal Navy?—I am.

1552. You have seen, I believe, a good deal of service, and you were at the capture of Sebastopol?—Yes.

1553. Have you turned your attention very much to cupola ships?—Yes.

1554. What experience have you had in Armstrong guns?—My only experience of the Armstrong guns was in experiments made with one in a cupola on board the "Trusty;" and one in a broadside port in the "Trusty," and two 110-pounders in a cupola on board the "Hazard."

1555. Was that experience of the same character as the experience that would be gained in action?—Particularly so in the "Trusty." As the two guns, that is to say, the one in the broadside, and the one in the cupola, were competing against each other, great rivalry ensued between the two, consequently they fired with the greatest rapidity that was possible.

1556. Do you recollect how many rounds were fired?—From the gun in the cupola I believe there were 96 rounds.

1557. In what time?—At different periods, we took several days.

1558. How many rounds were fired in succession at any one time?—The greatest number fired consecutively was seven rounds; we had intended to fire 12, but the splitting of a vent-piece prevented it.

1559. Will you state to the Committee what the result of your experience was?—The results of the firing from the shield were 96 rounds, and from the gun in the broadside port 40 rounds.

1560. What was the calibre of those guns?—They were 40-pounders.

1561. Each of them?—Each of them; one was within the cupola, and one was on the main deck of the "Trusty," through a broadside port. The gun in the cupola broke seven vent-pieces, and that in the main-deck broke four; in all 11 vent-pieces. These are my notes made at the time: the first vent-piece was broken after the 14th round; the second after the second round; the third after the sixth round; the fourth after the second. Those were in the shield. The next was on the main-deck: the fifth after the third round, and the sixth after the tenth round; the next was in the shield, being the seventh after the second round; the eighth was on the main-deck after the sixteenth round; the ninth after the nineteenth round was in the shield; the tenth after the nineteeth round was on the main-deck; the eleventh after the third round, was in the shield. The first vent-piece that was broken or split, jammed in the gun, and it put a stop to our experiments until it was cut out by an artisan, sufficiently to be drawn out, whom we telegraphed to Woolwich for, and that occupied between two and three days; we had to bring the ship into Sheerness from Shoeburyness, and that detained us for that time. As to the fifth vent-piece, that broke in the main-deck gun; we found the copper ring in the rear of the chamber much damaged, which had to be refaced before the gun could be used. The eighth vent-piece that broke in the main-deck gun jammed in the gun, but was cut out in a few minutes, by means of a lever; and for that time the gun could not be used. With respect to the vent-pieces, that is the extent of my experience on board the "Trusty."

1562. Have you any remarks to make with respect to any other parts of the guns?—No; I have no remarks to make. My notes were merely taken casually, being present to see that fair play was given to the shield.

1563. Can you state whether proper precautions were taken to secure the carrying out of all the peculiarities of the exercise for the Armstrong practice?—Every precaution was taken; and I may as well state that the experiments were carried out under the supervision of Captain Powell, C.B., and Mr. Liddell, the senior gunnery lieutenant of the "Excellent." The men were thoroughly drilled crews, picked for the occasion; and on all occasions the gunnery-lieutenant stood over the men, and insisted upon the details being most thoroughly carried out.

1564. Is that all the experience you have had of the Armstrong 40-pounders?—That is all the experience I have had of the Armstrong 40-pounder.

1565. Have you had any experience of the Armstrong 100-pounder, and if so, when and where?—As to the 110-pounder, which, I presume, is the same as on board the "Hazard," we had two mounted in the cupola, from which several rounds have been fired in quick succession at targets.

1566. Do you recollect how many were fired?—I do not recollect at this moment, but I think about 36 rounds altogether.

1567. Will

1567. Will you state to the Committee, if you please, what is the result of your experience with regard to these guns?—On one occasion in firing six rounds, quick firing, we found some inconvenience from the screw working stiffly, and we fired only six rounds in eight minutes, but this must not altogether be attributed to the screw; we had some difficulty in bringing the object on, in consequence of the cupola being stationary in the ship, and having to turn by moving the ship. On another occasion we could not screw the breech up in consequence of the cartridge being too large, and upon inquiry we found the cartridge had been made up on board the "Excellent," and in trying to get it out again it burst, and, of course, caused a great detention; but that struck me as rather an important point, as on service you often would have to make up your cartridges, and they may not always be the exact size; in all other respects those two guns worked very well.

1568. Nothing went wrong with regard to the vent-piece?—Nothing; on one or two occasions they worked a little stiff, but none were broken to my knowledge.

1569. Could you favour the Committee with your opinion generally with respect to the Armstrong gun, stating whether you consider it to be a good and safe gun for naval purposes or not?—Since those experiments were made, I have inquired largely about those guns, and I have heard of a good many vent-pieces blowing out; as long as there is any liability, to that I think that there is great danger between decks; beyond that I can hardly presume to give any opinion upon the gun.

1570. Colonel *Dunne.*] Do you think if that defect of the blowing out of the vent-pieces were cured, then the gun would be a good gun for the naval service?—I would prefer, if I were to commission a ship in time of war, having guns that were less complicated.

1571. Your chief objection is the liability to the destruction of those vent-pieces?—If I might say I had any objection at all, it would not be so much that, as the liability which there would be of the gun getting out of order.

1572. Then your objection is not to the vent-piece, because that might be made firm, but to the complication of the gun?—My objection is to the complication of the gun; if the vent-piece is made so firm as not to blow out or break, then the only objection is to the complication.

1573. But that objection remains till this moment?—It remains in the ordinary service breech-loader.

1574. You have a great objection to the breech-loader?—Yes.

1575. But is there not this advantage in the breech-loader on board ship, that with it you are not obliged to expose the men in ramming the shot home?—There may be a slight advantage; but with these small ports, a man is very nearly as much exposed in the rear of the gun as in the front.

1576. Therefore you think that advantage does not outweigh the disadvantage of the complication of the gun?—No; but I would explain that. I think in actual warfare we require an article with the minimum chances of getting out of order. Now with the muzzle-loader gun, you have only one chance of mishap, that is to say, its bursting.

1577. But that objection is with respect to any breech-loader?—Yes.

1578. It is not confined to the Armstrong gun?—It is not confined to the Armstrong gun.

1579. What was the date of those experiments to which you have referred?—The first were in September 1861. The second were in March 1862.

1580. Has not Mr. Westley Richards applied some mechanical power to prevent the vent-pieces breaking since that date; was it used by you?—I am not aware of anything of the kind.

1581. Therefore it could not have been used in those experiments?—I am not aware of it.

1582. Captain *Jervis.*] Do you remember what the position of the navy of this country was, previously to the introduction of the rifled gun on board ships; was it not considered extremely necessary, if possible, to get a rifled gun on board?—Yes, I remember that in 1856 or 1855 we had no rifled guns in the service.

1583. Was there not, at that time, considerable apprehension that the French were introducing rifled guns, and that they might obtain a superiority over us?—There was that apprehension, but I do not think that the rifled gun would ever decide an action; that is to say, at long range. I do not think that it would ever do much harm at sea.

1584. Are there not occasions on which a rifled gun could be of great importance?—At close quarters I do not see the advantage of it.

1585. But supposing you wanted to shell a fortress at long range, would not a rifled gun be an advantage?—Certainly it would be an advantage, but you can merely annoy the enemy at a long distance with the rifle gun. I do not think that you could destroy a ship where the guns are not stationary.

1586. But suppose a man-of-war is trying to annoy a fort?—For bombarding, and so on, I think the rifle guns are pre-eminent.

1587. Therefore, it is an advantage, to a certain extent, to have a rifled gun on board a man-of-war?—Of course it is a superior weapon, and more accurate in range.

1588. In 1856, the subject of rifled ordnance for men-of-war and even for siege batteries, was in a state of infancy, was it not; there was very little known on the subject?—Yes, very little. I candidly confess that I knew very little on the subject myself.

1589. But taking the armaments of any civilised power the rifled gun was in a state of infancy, whether with respect to the manufacturing, or the rifling, or the making of shell?—Yes.

1590. Since that time there has been a very great progress, has there not?—Yes.

1591. And the gun that you allude to at present as not being so good, owing to the vent-pieces breaking, would have been considered very good in 1856, would it not, as compared with any ordnance possessed by any other power?—I am hardly competent to answer that question, because I do not know what the ordnance of other powers was.

1592. Are you not aware what the rifled ordnance of the French navy was at about that time?—To a certain extent.

1593. Do you remember the Lancaster rifle gun?—Yes.

1594. The Armstrong gun is a very great improvement upon that, is it not?—Yes, as far as we can judge, because we know the Lancasters all burst.

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1595. But the Lancaster gun was, at that time, considered a great improvement upon any other large ordnance, was it not?—I believe so, for a distant range, but very uncertain.

1596. The Armstrong gun at present in service in the navy, although it has its defects, is very superior to the Lancaster gun of 1856, is it not?—Really I hardly think myself capable of giving an opinion; my knowledge of the Armstrong gun was confined to those experiments. I should be most happy to give any opinions with respect to ordnance generally, but I know little about this. I never saw the Lancaster gun fired myself.

1497. We have to inquire whether the expenditure for ordnance during the last six years has been for the public advantage or not; are you aware of any description of rifled gun which would be better adapted for the service than the one which has been adopted?—I certainly do not know of any, because I am very little conversant with rifled guns, I only speak from my practical knowledge of gunnery, and beyond that I am afraid I can give very little information.

1598. But you are not aware of any description of gun which you consider superior, and which you think ought to be introduced into the service?—No, I know of no other guns but the rifled Armstrong guns issued to the service, because it is the only one I have seen practically in use beyond seeing the Whitworth gun and models.

1599. Mr. *Laird.*] You have not seen the Whitworth gun fired, have you?—I saw a shot fired at Shoeburyness.

1600. Then you cannot give any opinion with respect to the relative merits of the two guns?—No, certainly not, as I only saw the experiment at Shoeburyness, and unless you are actually at a gun you cannot come to correct conclusions; the only difference is that I prefer a muzzle-loader on account of the chances of the breech-loader getting out of order.

1601. From what you saw of the use of the Armstrong breech-loader on board the "Trusty," you think it is too complicated for sea-going purposes?—I think it is too complicated for general purposes; it is very good for a chase gun, it is not so good for a broadside gun.

1602. Mr. *Vivian.*] Supposing that the "Trusty" and the other ship had been actually engaged with an enemy, what would have been the effect of the destruction of those vent-pieces?—On the first occasion with a one-gun vessel you would have lost your power of offence for three days, as the vent-piece got jammed in, or if there were numerous guns, you would have lost the power of one gun in the action, the breaking down of the fifth vent-piece that broke, would have put the gun *hors de combat* for half a day.

1603. After how many shots did that break?—After the third round.

1604. Then you would have had in that case two guns disabled?—Yes.

1605. Will you now go to the next gun?—The eighth vent-piece went after the 16th round.

1606. At the 16th round you would have had three guns disabled?—Yes, but the last was only disabled for a quarter of an hour.

1607. Therefore, for a quarter of an hour your third gun would have been disabled?—Yes, those were the only vent-pieces from which any detention would have arisen beyond supplying new ones; but we were supplied with the usual number, which is four; after the fourth we had to telegraph to Woolwich for others, which of course you could not do in action, and I borrowed some from other ships in harbour.

1608. In your opinion, would it be safe for a ship to go into action relying entirely upon Armstrong breech-loading guns?—No; from the experience that I had there, I certainly think not; I think you would be liable to lose the whole of your guns for a certain time, owing to the various casualties which occurred on that occasion.

1609. Can the Armstrong gun be used as a muzzle-loader?—The guns that I have seen used and the projectiles, certainly not. I am not aware of any method of using them as muzzle-loader guns.

1610. Then if a breech is damaged or a vent-piece destroyed, the gun becomes useless until a new vent-piece can be got in?—Certainly, or until whatever part is injured is replaced.

1611. Would you rather go into action with a ship armed entirely with 68-pounders, or entirely with Armstrong guns, as broadside guns?—Most decidedly with the 68-pounders, and particularly against iron ships.

1612. Then you consider that, except for long range, no advantage, but on the contrary a disadvantage, attaches to the use of the Armstrong gun on board ship?—Yes; from what I have seen of experiments against plates. A 110-pounder has not nearly the penetration of a 68-pounder, nor does it do the same damage at short range, and I am assuming that all actions must be fought at short range.

1613. Ship against ship?—Ship against ship.

1614. You were asked with respect to the Lancaster gun. Do you know what was the cause of the failure of the Lancaster gun?—The cause of the failure of the Lancaster guns was that the muzzles blew off, and they burst.

1615. Were those guns wrought iron or cast iron?—They were made of cast iron, I think.

1616. Are Sir William Armstrong's guns made of wrought iron or cast iron?—They are made of wrought iron.

—1617. Is it fair to compare a rifled gun, which is made of cast iron, to a rifled gun, which is made of wrought iron?—No; I think that is merely a matter of construction.

1618. Have you any reason to believe that the guns made on the Lancaster system would have burst if they had been made of wrought iron?—They certainly would not have been so liable to burst: but I do not know to what extent, for I know very little of the principles of gun making.

1619. As a naval officer you consider that the arming of ships of war with Armstrong guns would be dangerous to their efficiency?—Certainly; against iron ships especially.

1620. Mr. *Baring.*] In answering those questions which have been just put to you, when you said Armstrong guns you meant any breech-loading rifled guns?—Yes; any breech-loading rifled guns I have heard of, because they are all of them more or less complicated, and I am certain that in warfare, which is a very rough trade, we must have very simple articles. In the muzzle-loading there is the simple chance of bursting, whereas in the Armstrong there are five different parts, upon any one of which getting out of order your gun is *hors de combat.* In a gun on the wedge principle you have two or three parts that are liable to get out of order; therefore I have come to the conclusion that the simple muzzle-loading gun, if you can get it to do the same work, which

which apparently you can, is very much preferable to any breech-loading gun.

1621. In action, you prefer the smooth-bore gun to the rifle gun for broadside purposes?—I do not know; because the great thing is to get penetration. We have seen very great penetration with rifle guns; for instance, with Mr. Whitworth's gun, and supposing his gun to be equally durable with the smooth bore or any other gun, and that you can load it at the muzzle, I would then prefer the rifled gun.

1622. You want a rifled muzzle-loader, if you can get one?—Yes, if we can get one.

1623. Do you think that the weight for a ship of war is a matter that you would be able to master?—For the broadside ships. Of course the weight is of great importance; but on the principle on which I arm ships, the weight is of no importance. I prefer the heavier gun. I prefer a 12-ton gun to a 6-ton gun.

1624. You would be able to carry a gun of 12 tons?—There are ships now building which are to carry guns of 12½ tons; those are the orders I have received, and I am prepared to work a gun of 12½ tons.

1625. How many guns could you carry in each ship?—In the "Royal Sovereign," we shall carry five guns, weighing 12½ tons each.

1626. And you would prefer those guns to be muzzle-loaders?—Yes, I have asked to have them muzzle-loaders.

1627. And of course they will be rifled guns?—I do not believe that is decided. I do not know of a rifled gun of that weight.

1628. The question of rifling muzzle-loader guns—the question between Sir William Armstrong's and Mr. Whitworth's system—is at present before a committee, is it not?—Yes; it is, I believe, before a committee appointed for the purpose of comparing the two systems.

1629. At present we are very much in the dark as to the nature of those very heavy pieces of ordnance?—Yes; and so much so, that I do not know which we are to use, whether they are to be 300-pounder rifled muzzle-loaders, or 150-pounder smooth-bore guns.

1630. Captain *Jervis.*] The 300-pounder Armstrong gun is a muzzle-loader, is it not?—The drawings that I have received of the outline of the gun shows a muzzle loader.

1631. That which was tried at Shoeburyness with round shot, first of all, was a smooth bored-gun?—Yes; but I do not know that it was rifled.

1632. But it was a muzzle-loader then?—Yes; it was a muzzle-loader.

1633. Colonel *Dunne.*]Your opinion appears to be that in future naval actions will not be carried on at any great distance, nor is it desirable that you should have guns merely for the purpose of carrying actions on at long distances?—Certainly.

1634. You conceive that actions should be fought with powerful guns at nearer distances than those contemplated for rifle guns?—Yes; I think you would empty your magazine before you came to any conclusion in an action at long range; and now that we have a motive power which formerly we had not (for though we then preferred going close, we depended on the wind); I think no ship could show her face in England if she did not at once go as close as possible to her enemy.

1635. Therefore you think it is not necessary to have those complicated breech-loading guns?—No, except as chase guns; for tickling up a runaway fellow, they would be very useful.

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1636. Do you think, considering the inevitable oscillation of a ship in the water, that rifled guns could be used satisfactorily?—Certainly; we have always the disadvantage of the movement of the vessel.

1637. Lord *Robert Cecil.*] Do you contemplate a system of naval warfare in which guns at long range shall be entirely dispensed with?—I do contemplate that system in deciding any action.

1638. What would happen to a ship armed entirely with short-range guns if an enemy with a long-range gun came up to her?—I think you should always have chase guns.

1639. You think that there should be guns of both kinds on board a ship, just as in the olden time?—Yes.

1640. You would recommend that there should be two styles of guns; smooth-bored guns for close action, and then rifle guns for long chase?—In iron ships I should recommend, between decks, under the armour plating, only a gun for close quarters; that is to say, either a muzzle-loading smooth-bored gun, or a muzzle-loading rifle gun. Then on deck you can have, according to the size of the ship, one or two chase guns; but in close quarters you would not use them.

1641. Then those guns must be of the kind you call complicated?—No, not necessarily; we hear of the Whitworth muzzle-loaders, which are not complicated.

1642. You see no objection to a muzzle-loader for a chase gun?—No, certainly not.

1843. Mr. *Vivian.*] My question, with respect to whether the Armstrong gun could be used as a muzzle-loader or not, had no reference to the one experimental gun which was made as a muzzle-loader, but to the ordinary class of Armstrong guns issued to the service; can those guns be used as muzzle-loaders?—Certainly not, as far as my knowledge goes.

1644. Mr. *Baring.*] Was any official report sent of the failure of those vent-pieces in the "Trusty"?—I do not know; I was merely there as the inventor of the cupola.

1845. Who was in charge of the "Trusty"?—Captain Powell, who is now captain of the "Britannia."

1646. Mr. *Laird.*] Do you know how the "Warrior" and the "Black Prince" are fitted?—I cannot remember exactly, but I think you will find that the "Black Prince" has 68-pounders under her armour plating.

1847. And the chase guns as you describe?—Yes, and besides that, in her unprotected ends, I think she has four Armstrong breech-loaders.

1648. Are they Armstrong guns on the same principle as those you have on board the "Trusty"?—Yes.

1649. And you think they are too complicated for use on board a man-of-war?—I do, for general purposes.

1650. Mr. *Vivian.*] Are you acquainted with the American system of arming ships?—No, not beyond what I have read in the newspapers of what they are doing with turreted ships, putting twelve 20-ton guns in, and they are all muzzle-loaders.

1651. They have a gun called the Dahlgren gun have they not?—Yes.

1652. Will you describe to the Committee the nature of that gun?—I do not know the exact nature of it, beyond its being a muzzle loader.

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1653. The Dahlgren guns are 11 and 9-inch guns, are they not?—I think so.

1654. The largest guns in Her Majesty's navy is a 68-pounder, is it not?—Yes; that is not the largest bore; we have a hollow shot of 10-inch.

1655. But the guns with which ships are usually armed are 68-pounders?—Yes, that is the heaviest gun.

1656. What is the diameter of a 68-pounder?—Nine inches.

1657. Would not a vessel armed with Dahlgren 11-inch guns have an immense superiority over a vessel armed with 9-inch guns as broadside guns?—It does not depend on the calibre of the guns, but it depends on the charge of powder in proportion to the weight of the shot.

1658. But is it so at short range?—At short range, with the Dahlgren gun, I think their charges are rather lighter, but if they are not of sufficient strength to throw a proportionate charge with the greatest initial velocity to the shot, they would not do so much harm as a 68-pounder. I am not certain that our 68-pounder gun is not as effectual as the Dahlgren gun, because their charge is not sufficient for their shot.

1659. Even at short range?—Even at short range.

1660. Lord *Robert Cecil.*] You have been speaking of those guns which are the most effective at short range. What is your opinion with respect to the form of the projectile. Is the 68-pounder spherical shot as good as any other for short range?—For penetrating a plate, no doubt a flat-headed shot, when case hardened, is the best.

1661. But, taking all purposes together, which would you rather fight with, at short range, the spherical projectile or the flat-headed projectile?—I would prefer the flat-headed and hard-headed projectile.

1662. Does it break up as well as the other?—The 68-pounder projectile, if you hit repeatedly at the same place, has great effect, but in action it will be very difficult to do that; in action, where we never should hit twice in the same place, a projectile which penetrated would be the best.

1663. Colonel *Dunne.*] Would the making of a mere hole do a very great injury?—No; but a 68-pounder will not make a mere hole.

1664. But if the hole is filled with powder so as to form a shell, that is a real injury, is it not?—Yes.

1665. You think that a mere bolt fired through the side of a ship would not do a great injury?—I think not.

1666. Captain *Jervis.*] The hole could very easily be plugged up?—Yes, it could very easily be plugged up.

1667. Being very clean cut?—Yes.

1668. Have you seen an account of certain experiments with flat-headed shot at the end of the last century, at the instance of the Duke of Richmond?—No.

1669. Mr. *Vivian.*] Who invented the flat shot, do you know?—No, I do not know.

ISAMBARD BRUNEL, Esq.; called in, and Examined.

I. Brunel, Esq.

1670. *Chairman.*] Is this letter, dated the 27th April 1863 (*vide Appendix*), addressed by you to me as chairman of this Committee?—Yes.

1671. Have you any personal knowledge of the matter referred to in the correspondence you refer to?—No.

JOHN ANDERSON, Esq.; recalled, and further Examined.

J. Anderson, Esq.

1672. *Chairman.*] IN reply to question 1132, Mr. Whitworth having read a statement said, "This statement has been read to Mr. Anderson, and Mr. Anderson concurred in it," is that the fact?—If the Committee would allow me, I should like to read a short statement of the case as it appears to me.

1673. Will you be so kind as first to answer the question?—A mere "Yes" or "No," will not answer the question.

1674. But Mr. Whitworth read a certain statement to the Committee, and said he had read that statement to you, and that you concurred in it. Did you tell Mr. Whitworth that you concurred in it?—I could not answer that question without telling you all the circumstances connected with it, and after I have read the paper which I have prepared, it will be plain and simple.

1675. Mr. *Laird.*] If the matter is so simple, cannot you give a simple answer to the question?—A simple answer would not settle the question.

1676. Captain *Jervis.*] Mr. Whitworth distinctly puts in a statement contradicting your former evidence; did you agree with that statement, or did you not?—As you press me so hard I must make an explanation. About a fortnight before then Mr. Hulse called on me with a statement, and we read it over together; in most particulars it was nearly correct; there were one or two words which we should have very soon got over, and which we should have agreed upon, except the word "detail." He took it away with the intention of rectifying it, and was to submit it to me at a future time, in order that we might see whether we could agree upon it or not. Before he had sent that paper back again, I met Mr. Whitworth at dinner at the house of a common friend. After we had gone into another room, Mr. Whitworth took me on one side for a moment; there was a very animated conversation going on in which I was interested; but Mr. Whitworth read off that paper, which made hardly any impression on my mind at the time, and I was not disposed to enter into the merits of the thing then, as I had been in communication with Mr. Hulse. I did say, speaking in the usual complimentary way, "That was just about what took place;" but as for saying that I would subscribe to all that Mr. Whitworth said in his first examination, I could not do that.

1677. Did you tell Mr. Whitworth that you concurred in that statement?—It was done as I state; it was merely one of those passing remarks that one will make under such circumstances.

1678. But was the effect of what you said to convey to Mr. Whitworth's mind that you concurred in his statement?—It did not leave that impression on my own mind.

1679. You did not say that you concurred in that statement, or any words that would fairly convey

convey that impression?—I did not say more than three words on the subject.

1680. Did you say since that to any other person that you concurred in Mr. Whitworth's statement?—No, never.

1681. Captain *Jervis.*] You have seen Mr. Whitworth's statement since then, have you not?—No, I did see it, but I did not read it; I got a look at this evidence for two hours, and I told my assistant to read it for me, and to select those things that he thought I should agree upon, and also those things which he thought I should not agree upon. In looking them over I find there is very little that I should not agree with—the Secretary of State sanctioning the manufacture of Mr. Whitworth's gun. Mr. Whitworth seeing me in London, giving me the drawing, sending me the drawing of the 7-inch gun, my acknowledging them, and sending two drawings to Mr. Whitworth; the Whitworth company acknowledging those drawings—consulting at Woolwich with me; everything relating to the correspondence, there is hardly any difference of opinion about. The difference is all about that word "details." If we could clearly understand each other about that, the matter is quite clear and simple.

1682. *Chairman.*] Will you now read the statement to which you have referred?—Although my name has been frequently mentioned in the examinations on the subject of Mr. Whitworth's 7-inch gun, yet I beg to state most distinctly, that I form no party in this question; have no case of my own to defend, nor have I identified myself with any side, but am equally friendly with all; my position was simply this, that as Assistant Superintendent of the Royal Gun Factory, I was directed by the Secretary of State to make a gun according to a drawing to be supplied by Mr. Whitworth, and to put myself in communication with that gentleman. On the 16th of December 1861, Mr. Whitworth sent to me a tracing of the 7-inch gun (a copy of which has already been handed into the Committee; the full-sized drawing on the wall is an exact representation of that gun). It is important to observe, that this is the gun, whether good or not so good, which would have been constructed if I had at once commenced its manufacture, and which I would have done if without the training of the past three years; and this gun, so made, would have been to the entire satisfaction of Mr. Whitworth; my chief object will be, to point out where this gun agreed with, or differs from, that which has been made in the Royal Gun Factories, not for the purpose of proving that the latter is either better or worse than the former, but simply to fix positively their relation to each other, without bias or exaggeration, and to give a definite meaning to the word "details," for, on the meaning of that word the whole question will be found to turn. I at once commenced the study of its structure in all the details of materials to be employed, number, form and arrangements of parts, as also, the distribution of the materials, to meet in the proper proportion the several strains to which it will be subjected. Having been engaged in the study of built-up muzzle-loading guns for the previous 15 months, my mind, during the interval being in a progressive state, as will be seen by the half sections now exhibited, each drawn to a quarter scale, and having been occupied for the previous three years in the manufacture of the Armstrong guns, I was prepared to examine Mr. Whitworth's drawing with some little experience; a short examination convinced me that the gun was wrong, both in principle and in detail, and I felt sure, that if made as shown, it would not be satisfactory; such at least was my opinion, and which now, with my increased experience, I have not yet seen cause to alter. The four grand defects, as they appeared to me at that time were, first, the absence of a breech-piece of sufficient mass to take the longitudinal strain to which the gun is there exposed when fired with heavy charges, and which is a leading feature in the Armstrong guns. That instead thereof, a compound screw was introduced into three several layers, each of which, at the moment of firing, during the early stages of the gun, are almost sure to shift to some extent their relative positions, and thus to call into existence an element of weakness which I did not see how it was possible to prevent, or to avoid the unequal yielding that would occur; and from what I know of the weakness of the coil system in the longitudinal direction, if breech coils were used for that purpose, I felt convinced that the gun could not stand above a few rounds. Accordingly, the usual massive breech-piece employed by Sir William Armstrong, with the fibre of the iron in the longitudinal direction, at once suggested itself as the proper remedy. Second, the next defect, as it then appeared to me, was the breech screw, consisting of three screws of different diameters, formed upon one stem. The mechanical difficulty of making a sound breech, by having such accuracy as that the three several screws would each fit with the same precision, each into its own layer, was considerable; but that, perhaps, could have been got over by special arrangements in the tools employed; but I did not lay much stress upon that, and this of itself would not have raised an objection to its use, had it been the proper arrangement in other respects, according to my way of thinking, which it decidedly was not. The chief objection to this screw lies in the large area exposed to the influence of the fluid pressure, in the event of leakage, a contingency not only probable, but certain, with an open-ended tube, as shown in Mr. Whitworth's drawing. The area of circles being to each other as the squares of their diameters, it follows that if the pressure on the area of the bore is 49, then on the whole screw (which is sure to follow before a few rounds), this 49 of pressure would rise to five times the amount, viz., 244·1. This is a most formidable objection, that there was no getting over, but by reducing the screw's outer diameter, when the difficulty would be lessened in proportion. In the two drawings, $\frac{W}{68}$ and $\frac{W}{69}$, which I first submitted to Mr. Whitworth, this objection is obviated in two different ways. In the first, and that which I recommended as the best, the inner tube is close at the end, a most important improvement, which has been fully recognised by Mr. Whitworth. This close-ended tube is let into a close-ended breech-piece, which is a still greater improvement in my opinion, but which, up to this time has not met with so much acceptance, but will yet be adopted, I feel certain; but as this latter was not approved by Mr. Whitworth, it need not be further referred to. In the other drawing $\frac{W}{69}$, a single screw in a breech piece was shown, 12 inches in diameter, and having an area relatively of 144, that is to say, in the event of leakage, the pressure would rise from 49 to 144, but

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which is still 100 under the three screw arrangement. As will be seen hereafter, Mr. Whitworth approved of the close-ended tube, and a single screw of the above diameter, which has (in my opinion) no resemblance whatever to the plan shown on Mr. Whitworth's original drawing, even supposing it to be no improvement; third, the next great objection that offered itself to my mind, at the time was the mode of putting the gun together, namely, by hydraulic pressure; for some parts of guns I quite approve of this method, but for the general structure, it, in my opinion, does not afford such a firm holding power, nor is it so economical as the method adopted by Sir William Armstrong, namely, of expansion by heat, and the after shrinkage by withdrawal of temperature. As to which of the plans may be the best, is not the present question; the drawing of Mr. Whitworth's was intended for the one plan, while in the gun which was eventually made, the other was adopted. In forming an opinion, I was not without good proof that completely satisfied my own mind, that the shrinkage system would make the best gun in the present instance, as some few months previously the Secretary of State ordered four muzzle-loading 70-pounders to be made for Mr. Whitworth, two of them to be made by Mr. Whitworth, in his own way, and at his own works; the other two at Woolwich, on Sir William Armstrong's system of putting together. Previous to the ordeal of proof all looked equally sound, but the first gun, as made in Manchester, failed at the second round; the two similar guns which were made in the Royal Gun Factory, both went through their proof satisfactorily. With such a broad fact before me, and having no partiality either way, but a single regard only for that plan which seemed to afford the greatest likelihood of ultimate success, I chose the latter, not only because it was the system for which we were fully prepared and expert at, but also for its own sake, as of the two plans the most preferable; and judging by the results so far, I have every reason to be fully satisfied; and greatly fear that if the other plan had been employed, this gun would not have been so serviceable. So far as the three foregoing objections are concerned, they were merely my own opinions in considering Mr. Whitworth's drawing at that time; but as they have now become realized facts, in so far as the two guns are concerned, seeing that the one plan was departed from entirely and the other plan adopted, no amount of investigation, nor any quantity of reasoning, can ever alter them or explain them away. The facts will still remain, that the two guns are not the same.

I shall now resume the narrative of the successive stages of the correspondence. I received Mr. Whitworth's drawing on the 13th of December, and, on the 19th of that month, I wrote to Mr. Whitworth, enclosing the two drawings, $\frac{W}{68\ \&\ 69.}$ Both of these drawings are in exterior outline, and in diameter, and length of bore, similar to that supplied by Mr. Whitworth; and the letter contains these words:—"I have prepared two drawings, $\frac{W}{68\ \&\ 69}$, showing a gun finished to the outlines of your drawings, but constructed according to a simpler arrangement of the coils, and one which I would recommend for your consideration, in preference to your proposal to use hydraulic pressure and screwing the coils together. The only difference between the drawings is, that one has a solid tube and the other an open tube and breech screw. Either of these can be rifled according to your principle; but, of the two, the close-ended tube, for the sake of avoiding any joint in the powder chamber, would appear the best, but my desire is to carry out your wishes in this matter." During the previous month, I had been studying this subject. Of the numerous drawings which I had prepared, all coming towards the final gun, and of which I now exhibit four, A, B, C, and D, in addition to $\frac{W}{68\ \&\ 69}$, which are all correct copies of the original, still in the Drawing Office of the Royal Gun Factory, there is one in particular, marked C, that must be mentioned in connexion with the subject of the exterior hoop which has been so much referred to. This drawing is dated the 11th November 1861, a month before I had received Mr. Whitworth's drawing; and this drawing, C, is the more conspicuous, because it contains the hexagonal bore of Mr. Whitworth, and was being on that day designed by me for that purpose. In that gun, the thickness of metal over the powder chamber is 14 inches; that of Mr. Whitworth's gun is $10\frac{1}{2}$ inches; that of the plan finally adopted is $12\frac{1}{2}$ inches. These facts have to be remembered, as they presently will assume more importance in connexion with the origin of the exterior hoop. On the 23d December, Mr. Hulse called at the Royal Gun Factory. The whole subject was then well considered and discussed by each of us, from our own point of view. The gun was modified in several particulars; the two methods of breech shown in my drawings, $\frac{W}{68\ \&\ 69}$, were combined, thus giving a close-ended barrel, and a single breech screw, into a massive breech-piece. The trunnion was also modified, as will be seen by comparing these two drawings, $\frac{W}{68\ \&\ 82}$. With regard to the additional hoop over the powder chamber, I had, from the first, a very strong opinion on that point, and always looked upon the distribution of the material in Mr. Whitworth's gun as susceptible of improvement; at the same time, I do not by any means contradict the statement made by Mr. Hulse, that he, at this meeting, had drawn the pencil line to which he referred. It is quite likely to have been the case. But at the same time, let it be remembered that there was my drawing on the table, with the hoop in question; for all the drawings which I had, bearing on the subject, were shown to that gentlemen. Next day, after our interview, the 24th of December, I forwarded to the Whitworth Ordnance Company, an amended drawing of a gun, No. $\frac{W}{82}$, now exhibited, which was enclosed in a formal letter. On the 26th December, that is two days after, I received a reply from that Company, in which it is stated that the gun which I had now submitted, namely, $\frac{W}{82}$, the gun which, with some trifling modification in outline, was afterwards made for them in the Royal Gun Factory, is not the gun that Mr. Whitworth would have preferred, and giving me the whole responsibility, and allowing me to do as I pleased with "the details," as they are termed, but even yet, with the influence of our discussion only two days previous fresh on the mind of Mr. Hulse, they urged me to consider the propriety of omitting the exterior hoop over the powder chamber. During the next two days I was hard at work, trying to get rid of the hoop, but saw no way of escape, and so wrote to him on the last day of the

the year, that the said hoop is indispensable. As I was obdurate, the point was conceded, and the gun was so constructed according to my wishes. The tracing $\frac{W}{87}$, is that which received the signature of Mr. Whitworth; but afterwards, on studying the points closer, I took the liberty of altering $\frac{W}{87}$, to the lines of the large drawing shown on the wall, side by side with the drawing of Mr. Whitworth's gun, also full size. The several parts are shown in different colours, which will now enable me to show many other points of difference besides those which I have already named. The red lines on my large drawing are those of $\frac{W}{87}$, and thus the liberty taken by me can be correctly estimated. The two guns, viz., that which Mr. Whitworth would have preferred, and that which was constructed in the Royal Gun Factory, differ in the following particulars: first, Mr. Whitworth's gun consists of 24 distinct parts; the Royal Gun Factory gun of 12 distinct parts. Second, Mr. Whitworth's gun was intended and designed for being put together by hydraulic pressure; the Royal Gun Factory gun was designed for and put together by shrinkage. Third, in Mr. Whitworth's gun, the parts that had to be united were connected by screws; in the Royal Gun Factory's the parts to be joined were united by the process of welding. Fourth, in the one gun the inner tube or barrel is open at the breech end, and closed by a screw; in the Woolwich gun, it is solid and close, and without any joint. Fifth, the first gun is without the part technically termed the breech piece; in the other gun, the breech piece is one of the leading characteristics. Sixth, the breech plug of Mr. Whitworth's gun, consists of three screws, of different diameters, formed on one stem, and made to take hold, not only of the inner tube, but also of the second and third layers of tubes; the breech screw of the Royal Gun Factory gun is of one diameter throughout, and is screwed into the breech piece only, and butting hard against the solid end of the inner barrel. Seventh, the second tier of tubes in Mr. Whitworth's gun consists of eight parts, all screwed together into one long tube, which extends from the breech to the muzzle, and is screwed upon the second diameter of screw formed upon the breech plug; the second tier of the Royal Gun Factory gun consists of one long tube, extending from end to end of the gun, that at the breech having the iron of double thickness, with the fibre place longitudinally, the remainder being of coil of lesser thickness, with the fibre running circumferentially, which is the great leading feature of this gun. Eighth, the third tier of Mr. Whitworth's gun consists of six pieces, all screwed together into one piece, and extending to the extremity of the breech, and screwed upon the breech plug; the third tier of the Royal Gun Factory gun consists of two pieces, and only extends a little beyond the trunnion, the remaining space being made up by the greater thickness of the breech piece, which is part of the second tier. Ninth, the fourth tier of Mr. Whitworth's gun consists of four pieces not united; the fourth tier of the Royal Gun Factory gun comprises three pieces not united, but with the last breech hoop made to hook on to the breech piece, thus giving to the breech piece increased security. Tenth, the fifth tier of Mr. Whitworth's gun consists of three plain pieces, and one trunnion piece, all screwed together into one long piece; the fifth tier of the Royal Gun Factory gun consists of two plain pieces, and the trunnion piece; the last of the plain hoops being hooked on to the hoop under it, and which again is hooked on the breech piece, thus tying all three together. Eleventh, there is no sixth tier upon Mr. Whitworth's gun; the sixth tier of the Royal Gun Factory gun consists of one large hoop, to strengthen the gun over the powder chamber. In addition to the above, the two guns differ in the distribution of the material, and also in the disposition of the materials for resisting both lateral and longitudinal strain, and, as will be seen by the drawings exhibited, they also differ in their general outlines. So far as I am capable of judging, the two guns are quite distinct in all their leading features. It is not for me to say which is the best or which is the worst gun; nor am I now called upon to express such an opinion, but this I will say, in the construction of the gun in the Royal Gun Factory for Mr. Whitworth, that the whole experience gained by that department during the past three years, in the manufacture of the Armstrong gun, was made available.

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Had the several conditions of these transactions been entirely the reverse of what they were, that Mr. Whitworth had been manufacturing his guns on an extensive scale for several years, and that the Royal Gun Factory ordered from that gentleman a gun on their plan, and submitted the drawing $\frac{W}{87}$, the same plan as that which was constructed for Mr. Whitworth, in the Royal Gun Factory; that the similar objections, drawings, correspondence, and interviews, had all taken place, and that ultimately by some means or other, he had so far persuaded us into his own view, convincing us that the massive breech piece was bad, that the three-screw arrangement was better than a single screw, that putting together by shrinkage was less to be depended on than the hydraulic press, and so on up every step of the ladder, until ultimately he obtained full responsibility, and was permitted to make the gun in his own way, and on the plan of the drawing which he submitted to me, and that this gun was made, and found to turn out to our entire satisfaction when put in this shape, it does seem to me, that the view which would then be taken of this matter would be modified, and that however much I might insist that they were the same guns only altered in the details, it would yet be impossible for that gentleman to believe in his own mind, but that, after all, the gun was really and truly a veritable Whitworth, notwithstanding any similarity between the two, which I might insist upon.

1683. Will you be so good as to take this printed copy of the paper which was read to you, and in which you say you only objected to two or three words, and point out to the Committee the words to which you objected?—It is a very large paper, and I am not sure that I could detect them; there is a great deal in this paper that I know nothing at all about.

1684. Was not the whole of that paper shown to you?—I really could not say; looking at it now I should not suppose I had ever seen it before, or heard it read.

1685. *Chairman* (to Mr. *Whitworth*).] Is the paper which you put in before this Committee the paper which you read to Mr. Anderson?—Yes, I read every line of it to Mr. Anderson.

1686. (To Mr. *Anderson*).] Then I will repeat my question; you stated that there were some few words that you had objected to, will you be kind enough to point out which words they were?—I must

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—I must really say that the paper having been read to me under the circumstances I have stated, coming upon me hurriedly in that way, I think it would be very sharp practice to call upon me, before a Committee of Honourable Members of the House of Commons, to point out those words off-hand.

1687. Mr. *Laird.*] The question is, did you concur in all the statements in that paper?—When I made the passing compliment which I have referred to, I did not think of going into the question, as I have stated.

1688. But if there had been anything very far contrary to your views in that paper, is it likely that you would have assented to it at all?—I have not yet stated that there was anything contrary to my views, for I have not read the paper yet.

1689. *Chairman* (to Mr. *Hulse*).] Is that the same paper which you submitted to Mr. Anderson?—I believe it to be the same as I read to Mr. Anderson at Woolwich, and in which he concurred.

1690. Mr. *Baring.*] Did you leave a copy of it with Mr. Anderson?—No, I did not; the only expression of opinion was by Mr. Anderson's own chief clerk, Mr. Baker, and he objected to the expression, "the outlines of the gun being the same," and the reason assigned was, that they had added the outside hoop instead of myself suggesting it; but with that exception, there was a perfect agreement between Mr. Anderson, Mr. Sandeman, and Mr. Baker with the statement. (Mr. *Anderson.*)—With respect to the meeting on that day, I beg most distinctly to state that there was also the word "details" objected to. Mr. Sandeman, my chief draughtsman, is also in the room, who can be examined on that point.

1691. *Chairman.*] It being the fact that this paper was twice read to you, once by Mr. Hulse, when you objected to certain words which it contained, and once by Mr. Whitworth, when you made no objection at all, will you please to point out to the Committee the words in that paper to which you objected when you were speaking to Mr. Hulse?—If it is the same paper as Mr. Hulse read to me, the only words that I objected to were the word "detail" and the words which referred to the general outline of the gun. Those were the only strong words I objected to. (Mr. *Hulse.*)—I do not know that Mr. Anderson objected to any words. On the contrary, there was perfect acquiescence on Mr. Anderson's part to everything that I then read to him.

1692. Captain *Jervis* (to Mr. *Hulse*).] Is this paper, which was read by Mr. Whitworth to the Committee, an identical copy, word for word, of the paper which you read to Mr. Anderson?—I cannot say that it is an identical copy, but I have no knowledge that there was any alteration, since it was a simple history.

1693. But my question is whether this is, word for word, the same which you read to Mr. Anderson?—I cannot state that absolutely, but it is so to the best of my belief. It is substantially the same.

1694. But is it the same?—To the best of my belief it is the same; there may be abbreviations.

1695. Mr. *Dodson.*] It is not, however, a copy?—It is not a verbatim copy.

1696. Captain *Jervis.*] Can you put in the original paper which was read to Mr. Anderson?—(Mr. *Hulse.*)—I am afraid it is not in existence.

1697. Why was it destroyed?—If destroyed it would be simply because we had too great an accumulation of papers.

1698. Do you mean to say that a paper which you drew out as a statement for this Committee, and which you intended to submit to them, you destroyed as a piece of waste paper?—I do not say that it is destroyed, but I believe it is not in existence now; but it contained no other words of importance beyond what are contained in the paper which has been laid before the Committee.

1699. Having shown Mr. Anderson a paper which you intended to show to the Committee, do you state that you destroyed it as not being worth keeping?—I do not know that I destroyed it.

1700. Then who did destroy it?—I do not know.

1701. Is it in your office?—If it exists at all, it is in my office.

1702. Have you kept a copy?—No.

1703. Is it not the habit of your office to keep copies of documents?—Unless it is of more importance than that paper, it is not.

1704. Do you consider this paper of no importance?—I did not consider it of sufficient importance to keep a copy of it.

1705. Did you not consider it the basis of the whole case which you were going to submit to the Committee?—I had not the slightest knowledge that I was to be examined.

1706. Did you not know Mr. Whitworth was to be examined?—No; not except on the general question.

1707. You did not know that Mr. Whitworth was to put in this statement which he did put in?—No.

1708. Did you not assist him in drawing it out?—I did not.

1709. Colonel *Dunne.*] From what paper was the paper which is printed here, and which was put in by Mr. Whitworth, drawn up?—It was drawn up from a written statement by Mr. Whitworth.

1710. Mr. Whitworth drew it up himself, did he?—Yes.

1711. Captain *Jervis* (to Mr. *Whitworth*).]—Did you draw up this statement yourself?—Entirely.

1712. Who assisted you in drawing it up?—Mr. Aston.

1713. Only?—Only.

1714. Mr. Hulse was not consulted, was he?—Mr. Hulse was in Manchester.

1715. Did you and Mr. Aston draw up a paper separately from that which Mr. Hulse showed to Mr. Anderson?—Mr. Hulse went down to Woolwich, and had an interview with Mr. Anderson. He then drew up a paper, and read it to Mr. Anderson, a paper in which I understood Mr. Anderson concurred. Mr. Hulse went back to Manchester, and then Mr. Aston and myself drew up a paper for me to read to Mr. Anderson, instead of my going to Woolwich. I met Mr. Anderson at a friend's house, and I read the paper to him which I afterwards read to the Committee, I believe, word for word; and in that Mr. Anderson stated he concurred. I stated to Mr. Aston that I had read it to Mr. Anderson, and that he concurred; when Mr. Aston said, "you had better make a memorandum of that." This (*producing a piece of paper*) is the memorandum made:—

made:—" I read this to Mr. Anderson to-night, and he said he agreed with the whole of it," for I knew that there was a very serious charge, which was made against me by the Ordnance Select Committee, and I was very uncomfortable about it. I told Mr. Aston that I had read the paper to Mr. Anderson, and that he agreed with the whole of it. Mr. Aston also said immediately afterwards: I said to Mr. Anderson, " have you heard Mr. Whitworth's statement to-night?" Mr. Anderson replied, " yes;" and I agreed with every line of it. I asked Mr. Anderson, " do you consider that Mr. Whitworth's assertion that the 7-inch gun was made according to drawings supplied by him, was contrary to the truth?" and Mr. Anderson replied, " certainly not."

1716. Captain *Jervis.*] Is this paper which was read to Mr. Anderson identical with the paper which Mr. Hulse showed to Mr. Anderson?—I believe so.

1717. Did you have it when you drew up this statement?—Yes; Mr. Aston wrote it. I made no alteration.

1718. You and Mr. Aston together drew up this paper?—From the one that Mr. Hulse had read to Mr. Anderson.

1719. Did you copy it word for word, or did you make certain alterations?—Mr. Aston wrote it.

1720. Were you a consenting party to certain alterations?—No; and I believe there are no alterations.

1721. Colonel *Dunne.*] Did you read yourself to Mr. Anderson the identical paper which you read before this Committee?—Certainly.

1722. Captain *Jervis* (to Mr. *Aston*).] Is this paper put in by Mr. Whitworth a copy of the identical paper which Mr. Hulse showed to Mr. Anderson?—To the best of my belief it is, as far as the statement made by Mr. Hulse goes, an identical copy, but I believe the letters are set out more fully, and that that is the only difference.

1723. Probably the words which Mr. Anderson objected to are left out; is that so?—No, they are there still.

1724. Mr. *Baring.*] The words are there still?—Yes.

1725. Did you know when that was written that Mr. Anderson objected to those words?—No, I only hear it now from Mr. Anderson?

1726. And you now see that the words which he objected to were in the paper?—That they *are* in.

1727. Captain *Jervis.*] Will you point out the words?—I think the honourable Member will find them at page 14: " It was, however, always intended by me that the details of construction were to be such as could be most conveniently made by Mr. Anderson."

1728. And those are the words that Mr. Anderson objected to, are they?—I do not know, but those are the words which relate to detail. The honourable Member can judge of the rest as well as I can.

1729. Is this an identical copy of the paper which Mr. Hulse read over to Mr. Anderson?—I have already told the honourable Member that I believe not. I stated that, as far as Mr. Hulse's statements were concerned, I believed they were copied out *verbatim*, but that with respect to the letters, they were set out more fully.

1730. Then you do not know whether that portion which Mr. Anderson objected to in Mr. Hulse's statements has been at all altered in this statement?—I do not know. I was not present at the conversation.

1731. Have you not been informed by Mr. Hulse as to what portion Mr. Anderson objected to?—No; I did not understand that Mr. Anderson objected to it; I had Mr. Hulse's first statement, and I gave it back.

1732. Then what has become of it; do you know?—Mr. Hulse will tell you that.

1733. Mr. *Baring.*] You did not understand from Mr. Hulse that Mr. Anderson had made any objection?—No.

1734. And you inserted nothing into the paper which you believe Mr. Anderson objected to?—No; all I know is, that this statement, which Mr. Whitworth has read, was read over to Mr. Anderson from beginning to end, every word of it.

1735. Captain *Jervis.*] But are we to understand that the statement which Mr. Hulse read over to Mr. Anderson is not identical with the statement which Mr. Whitworth read over to him?—I am not able to say.

1736. Did you not state just now that it was not so?—I explained that I believed the only difference was that the letters were set out more fully.

1737. Lord *Robert Cecil.*] Were the two papers ever read together, so that you could be able to speak with certainty with respect to their differing or not differing from one another?—Not to my knowledge.

1738. Then what you now state, you state from vague recollection?—From the fact that the two papers were drawn up from letters, and that to any extent to which they differed, I believe they were corrected by Mr. Hulse.

1739. Sir *Frederick Smith.*] Is it not usual in your office, when you send out a letter, to have an entry in your books made?—Mr. Hulse will be able to answer that question.

1740. Colonel *Dunne* (to Mr. *Anderson*).] When was that paper which you have just read drawn up?—It was drawn up on Friday afternoon.

1741. But it is a criticism on the construction of the Whitworth gun as compared with that of the Armstrong gun, is it not?—No; it is merely comparing the two drawings.

1742. But giving a preference to one drawing over the other?—No, it is not even that; it is merely giving my opinion when I made the alterations.

1743. But those alterations were not Mr. Whitworth's alterations?—Mr. Whitworth sanctioned them.

1744. Was that done through Mr. Hulse?—No; it was done through letters which will be put in.

1745. There was a final gun agreed upon between you and Mr. Whitworth, or Mr. Hulse for him, was there not?—Yes.

1746. Was that signed?—Ultimately it was.

1747. I understand you to say that you made further alterations after that signature?—Yes.

1748. Did you communicate those alterations either to Mr. Whitworth or to Mr. Hulse?—I think I did verbally, but they were of no great importance.

1749. Would those alterations appear to a person looking at the gun?—No, he would not know.

1750. Therefore, is it your opinion that Mr.

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Whitworth was justified in speaking of that gun as his gun in his letter to the "Times"?—I would rather not be mixed up with that question, if you would excuse me.

1751. Taking the gun altogether, do you think that Mr. Whitworth could be accused of a deliberate misstatement in speaking of the gun as his gun?—My impression was, from first to last, that it was all a misunderstanding; and if it had not been for those letters in the newspapers, there would have been nothing heard of this. Mr. Whitworth and myself were one in the matter.

1752. But you do not consider that Mr. Whitworth made a misstatement in the "Times," do you?—I thought it a misstatement. I should like to say that, after the thing began to get important, another letter came out in the "London Review." On the Monday after that, Mr. Aston was waiting to see me when I got home from the War Office, at six o'clock in the evening: he appeared in trouble, and he said, "Was it so?" (referring to those statements which were in the papers); and I told him that it was as the "London Review" said.

1753. My question is merely whether you consider that gun so far fulfils the wishes of Mr. Whitworth that he could trust his experiment to it, assuming that the gun was his gun?—Mr. Whitworth's gave the first design, and we made this other gun for him.

1754. You made it for him as near as you could?—I tried to conform to his wishes in all respects.

1755. Lord *Robert Cecil.*] The design was his, and the skill was yours; was that it?—No, that is not it quite.

1756. Captain *Jervis.*] Taking the effect of the charge upon the two guns, would that be identical?—I do not know that; I could not say. I think the lower gun is the strongest of the two.

1757. Have you not, in your statement, pointed out that the pressure of the fluid would act very differently on the breech?—That is my opinion.

1758. If the guns were identical, or similar, would there be that difference in the effect of the charge?—It was my opinion that the upper gun was not strong enough.

1759. But without going to the mere strength of the gun, is the construction so similar that the charge would have the same effect on each?—I think it would be more likely to injure the upper than the lower gun; the gas cannot get out in the lower gun so as to act on the screw.

1760. Therefore the two guns are not identical, even in principle?—Any one can see that they are not identical.

1761. Therefore the gun was not made to the drawing, or even to the principle of the drawing, that was sent in by Mr. Whitworth?—No, it certainly was not.

1762. Mr. *Beecroft.*] Have those guns been tried?—I think one has.

1763. Has the upper one been tried?—No.

1764. Then you can draw no comparison between them, can you?—One was a drawing of a gun sent to me to be made, and which I objected to. I made the lower gun; and it is not a question which was the better or the worse gun: it is a question whether they are the same guns.

1765. However, the lower gun has been tried, and the upper gun has not been tried?—No.

1766. Mr. *Baring.*] Do I understand you to say, that this gun, as constructed by you (the 7-ton gun) differs in the principle of construction from the ordinary Armstrong principle of construction for heavy muzzle-loading guns?—It is made exactly in the same way as the Armstrong breech-loading guns are made.

1767. Is there any difference in principle with respect to the distribution of metal, between that gun and the ordinary Armstrong gun?—If I were to say that it was the same, that would be very wrong; but all guns have a great resemblance in that respect. This is Sir William Armstrong's 100-pounder, and this is Mr. Whitworth's breech-loading gun (*referring to Drawings*), and they both have the character of those two drawings on the wall.

1768. Upon which system of construction is that seven-ton gun made, Mr. Whitworth's or Sir William Armstrong's?—It is Sir William Armstrong's system.

1769. The system of construction is Sir William Armstrong's?—Yes.

1770. Mr. *Vivian.*] Is there no substantial difference between the 7-inch Whitworth gun, and the 7-inch Armstrong gun, in the distribution of the metal?—Yes, there is a very considerable difference.

1771. Then, is it the fact that "the metal is not differently distributed in the Whitworth gun and the Armstrong service gun, and that the form is not different in any degree worth notice"?—There is a very great difference.

1772. In regard to the difference between the gun originally designed by Mr. Whitworth and the gun which you eventually manufactured for him, are the outlines of those two guns substantially the same?—No, the red lines and the blue lines show the difference.

1773. What difference is there in section?—The one is about 10½ inches, and the other about 12½ inches.

1774. Do you mean above the powder-chamber?—Above the powder-chamber.

1775. Then there is a difference of two inches of metal more in the one than in the other?—Yes.

1776. By whom was that outer hoop suggested?—I was under the impression that it was my own for a month before Mr. Hulse made the pencil line.

1777. It is most probably one of those questions which, where practical men are discussing schemes together, arise in the course of the discussion, it being difficult to determine who first made the suggestion?—I know that I had made the drawing with that hoop on a month before Mr. Hulse made the pencil line.

1778. Without going into the details of manufacture, the only substantial difference between the distribution of the metal in the two guns is the 2-inch ring over the powder-chamber?—It is very much greater than that.

1779. But, without going into the details of the manufacture, is it not the fact that the only substantial difference between the distribution of the metal in the two guns is as I have mentioned?—Yes; there are two inches more metal over the powder-chamber.

1780. Would it have been equally easy for you, with the tools and workmen which you possess, to construct the gun on the design originally made by Mr. Whitworth as upon the design which was eventually decided upon for the construction of this gun?—We were not so well cut out for making the former guns; but I dare say that we could have done it by getting the necessary things.

1781. The

1781. The gun which you eventually made was more in accordance with your system of manufacture?—Yes.

1782. You attribute additional strength to that gun, but that of course is a matter of opinion only?—I think it is more than opinion.

1783. But the upper gun was never constructed, was it?—No, not the gun itself; but I am quite of opinion that the latter gun is very much better.

1784. Then it is a matter of opinion?—Yes.

1785. You gave the Committee the sectional area of the breech-screw. In that calculation you assumed the largest sectional area, the sectional area of the last screw, did you not?—Yes.

1786. In your judgment, would the gases act upon the last screw?—If they reached them.

1787. But would they reach them?—If there were any slackening they would.

1788. Is there any apprehension that the gases could pass round those screws, so as to act upon the last screw?—I have seen very serious mishaps through the gas getting into the larger area.

1789. That is alleged to be one of the grave errors made by Sir William Armstrong, is it not?—Any one that does it is sure to suffer for it.

1790. Do you apprehend that, from the construction of that gun, the gases would have passed round the worms of those screws, so as to act upon the external screw?—If the gas get out in that way, it would get into equilibrium no doubt.

1791. But is it likely that the gas would get into equilibrium?—The gas is certain to get to the area, if there is nothing to prevent it, if the leakage once began.

1792. Is it likely that it would begin?—The most likely thing that could be.

1793. You apprehend that the gas would pass round the worms of the screws upon each discharge, so as to act on the rear screw?—It has only to get past once.

1794. But you apprehend that it would pass on that one occasion?—I fear that would happen very soon when the gun got shaken.

1795. Could it pass without the screw upsetting or unwinding?—Yes; however nicely things may fit, the gunpowder is very searching, and finds its way where there is any crevice.

1796. Is not that a matter of opinion, on which engineers of guns may differ?—We have so many accidents arising that it is more than a matter of opinion.

1797. Has that upper gun ever been made or tried?—No.

1798. Then it is a matter of opinion?—Yes, as far as that gun is concerned, it is a matter of opinion; there are many fine points about that gun. There is no man living who has done so much to perfect the tools and refine the workmanship, so as to produce correct fitting, as Mr. Whitworth. It has pained me very much to have to go into the matter of that gun, but still the broad fact remains.

1799. That is to say, the broad opinion remains as far as you are concerned?—Yes.

1800. You stated in the paper you read that the one gun consists of 24 parts, and the other of 12 parts; but of how many parts does each of those tubes consist which form the lower gun?—They are welded into one, so that they are truly one system (as any bar of iron may be made out of little bits), although the welds may not be so strong.

1801. You estimate the strength of a welded surface at 14 tons, and of a solid surface at 22 tons?—That is quite true.

1802. Of how many separate rings does the second tube consist?—Four besides the breech-piece. I will draw a line where the breech-piece comes (*The Witness drew a line*).

1803. Then, that which appears as one piece in the drawing actually consists of five pieces?—That has been made out of five pieces.

1804. It consists of five pieces, does it not?—It was made out of five pieces.

1805. With all the imperfections of the weld?—Yes.

1806. Then may it not be open to an engineering question, whether the screw is not a stronger attachment than the weld?—I think it is stronger.

1807. Then no disadvantage would arise from the gun consisting of 24 parts, if those parts were screwed together?—I did not say that it would.

1808. Now take the next hoop, coloured yellow and blue: how many parts does that consist of?—Each of one part.

1809. And the next hoop consists of how many parts?—Each of those are one part.

1810. Now take the next hoop?—All the others here are one part.

1811. Then from the original twelve we must deduct one, and add five?—Yes, if you go back in that sort of way.

1812. Consequently, the lower gun consists of 16 parts, as against 24 in the other?—Yes, taking it in that way.

1813. But you are not prepared to say that the other gun would not be stronger, inasmuch as the attachment is made by screws?—No; I will not say that I like the screw in many respects for many parts.

1814. Now, with respect to the one solid breech-screw, I presume the action of the shot or the recoil upon the internal tube would cause it to thrust against that large screw?—Yes.

1815. Is it not to be conceived that that thrust would be quite equal to the action of the powder against the small surface of the upper screw?—And it might break the inner barrel. I daresay that would be likely.

1816. It is quite possible, is it not, that the gun, as constructed, is not so strong, or not stronger, than the gun as designed?—I think it is stronger.

1817. But looking broadly at the matter: looking at this fact, that the 7-inch gun, as hitherto constructed for the use of Her Majesty's service and designed by Sir William Armstrong, weighed four tons, and that the 7-inch gun designed by Mr. Whitworth weighed 7 tons 8 cwt., is there not in your judgment such a material difference between the two as would entitle Mr. Whitworth, as the architect of the 7-ton gun, to claim it as his gun, contrasted with the ordinary service 4-ton gun?—There is no similarity between the two. The one is a 4-ton gun breech-loading, and the other is a muzzle-loading gun of 7 tons 8 cwt.

1818. So that there was a substantial novelty in the general outline of the gun, as compared with the guns in use in the service as designed by Sir William Armstrong?—It is not the same kind of gun at all, and the two will not compare.

1819. Novelty enough to justify Mr. Whitworth, when he described his gun, in saying that he had designed the gun of a novel form compared with that in use in the service?—It does not at all resemble the Armstrong guns.

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1820. Then it was a gun upon a novel form?—Yes, quite distinct.

1821. Then I understand you to say the question as to whether he was right in claiming that gun as his gun in your mind resolves itself into rather a question of the details of the carrying out of the gun, and not of its general form. But what is meant by the word "details"?—If you like to call the changes that are made in that gun "details," that would be so.

1822. Mr. *Baring.*] With reference to the application of this word "details," do you consider the power of the gun to resist the explosion of the charge of powder to be a matter of detail of construction, or of principle of construction?—Yes, but still it is rather a difficult question to answer.

1823. The question appears to me to be whether the system of construction of Sir William Armstrong's guns with respect to the power of resistance to large charges of powder is the system upon which this seven ton gun was constructed; do you agree with me in that?—Yes; that gun made for Mr. Whitworth was on Sir William Armstrong's principle of putting the gun together.

1824. Therefore, in respect to the power of the gun to resist the charge of powder, Sir William Armstrong must have the credit of it?—So far as that lower gun is concerned, he must.

1825. That is the only gun constructed by you for Mr. Whitworth of that size?—Yes.

1826. Therefore you think Mr. Whitworth has no right to claim the credit of the construction of that gun at all?—Not of the lower gun.

1827. That being the gun which he claimed the credit of constructing in the letter which he has read to the Committee addressed to the "Times"?—It seems to me that they gave way in every point, one after another, and that ultimately it came to be a real Armstrong gun in the mode of putting it together.

1828. Then the Committee are to understand that you, having been the assistant superintendent of the Royal Gun Factory, and having made the gun yourself, are of opinion that it is made on the Armstrong principle, and not on any system of construction put on paper by Mr. Whitworth?—That is my opinion.

1829. Therefore, in your opinion, Mr. Whitworth has no right to claim that it is on any principle of construction suggested by him that that gun was made?—The principle of construction is Sir William Armstrong's, and not Mr. Whitworth's.

1830. Do you consider that the principle of construction of the gun, that is to say, the strengthening of the gun by coils, as is done here, in order to enable it to resist very large charges of powder, is an important part of the construction of the gun, or a mere matter of detail?—If it were the coils alone, I do not know that it could be called Sir William Armstrong's entirely; but the design of that very breech-piece and coils, with the whole of the system of putting the gun together, I attribute more to what Sir William Armstrong has been doing; Mr. Whitworth has been going in another direction rather, that is to say, screwing the parts together, and using hydraulic pressure; both plans are very good, and are free from certain inherent defects which belong to the other system; nevertheless they are two distinct systems, proceeding on two distinct principles, and putting the guns together in two distinct ways.

1831. Has Mr. Whitworth ever constructed a gun on his principle which you have seen; a gun which has been sent in by the Ordnance Select Committee, made entirely of homogeneous metal, and screwed together in the way in which that gun was proposed to be screwed together?—I rather think that there is one at Shoeburyness.

1832. Is it a breech-loader, or a muzzle-loader?—I do not know.

1833. Besides that 12-pounder, have you ever seen or heard of a gun capable of standing 25 pounds of powder, like this gun constructed by Mr. Whithworth entirely of homogeneous metal, screwed together in the way in which that gun is screwed?—No, I have not.

1834. What charges of powder have the large guns built upon the Armstrong principle stood?—The largest was, I believe, that of Mr. Thomas's, the other day, 50 pounds.

1835. Those guns were built up on the Armstrong principle, were they not?—Yes, and this lower gun was fired off with 27 pounds of powder, if I recollect rightly.

1836. Practically, as far as you know, no gun has been constructed by Mr. Whitworth, or under his orders, which can compare with the Armstrong principle of construction for large guns?—I do not think that there have been any such made.

Jovis, 30° *die Aprilis*, 1863.

MEMBERS PRESENT:

Mr. Baring.	Captain Jervis.
Mr. Beecroft.	Mr. Laird.
Col. Dunne.	Mr. Monsell.
Sir John Hay.	Major O'Reilly.
Marquis of Hartington.	Mr. Vivian.

THE RIGHT HON. WILLIAM MONSELL, IN THE CHAIR.

JOHN ANDERSON, Esq., recalled; and further Examined.

1837. Mr. *Vivian.*] HAD Sir William Armstrong anything to do with any of the drawings for the Whitworth 7-inch gun, which you sent down to Manchester?—No.

1838. Had he anything to do personally with the manufacture of the Whitworth 7-inch gun?—Not personally.

1839. What is now the condition of the gun?—It is defective in the bore.

1840. Is it not thought necessary to take out the inner tube and put in a new one, though it has not fired more than 20 or 30 rounds?—Yes.

1841. What do you now consider to be the best metal for the inner tube of a built-up gun?—Steel.

1842. Would you, if homogeneous metal were used for the inner tube of a built-up gun, have the end of the inner tube left solid?—Yes.

1843. The plan originally acted upon, and which is still advocated by Sir William Armstrong, is to make the inner tube of coils, is it not?—Of steel, I think.

1844. But what I have mentioned is the plan which Sir William Armstrong originally proposed?—Until recently Sir William Armstrong preferred the coil, but he has been making experiments with steel. I do not speak from my own knowledge, but I believe that he would now prefer steel, and always would have done so, if it could be depended on.

1845. Have any of the guns issued to the service been made with solid steel inner tubes?—I am not sure; some one or two may have been.

1846. The practice hitherto has been to make such tubes of coils, has it not?—Yes.

1847. Have not many of those inner tubes given way at the weld?—Yes, a good many of them.

1848. Have those guns which were made with steel interior tubes been proved?—One hundred-pounder which has been used for proving the vents with a steel interior, stood a great many rounds, and is now very perfect in the interior.

1849. Then Sir William Armstrong has considered it advantageous to change his system by discarding the coiled interior tube, and adopting the steel tube; is that so?—Sir William Armstrong preferred steel before he began with the coil for the inner barrel, but was afraid to risk it, owing to the brittleness of the steel; it is only of late that we seem to be getting over that brittleness, and getting toughness as well as its other good qualities.

1850. You heard Mr. Whitworth say that he considered welded wrought iron not to be a fit metal for making guns. Do you concur in that opinion?—No.

1851. You also heard Mr. Whitworth state, that he considered it absurd to build up a 6-pounder or 12-pounder gun. Do you agree in that opinion?—The 6-pounder I should prefer in one piece, and even the 12-pounder; if the steel was of the proper quality, I should very much prefer it of one piece. At the same time, I have no hesitation in saying that as far as our Woolwich experience goes, it would not warrant us in letting steel guns go into the service.

1852. If you use homogeneous metal, would you anneal it in the solid state, or after it is rough bored?—It would be done more thoroughly after it is rough bored.

1853. Do you think, considering the great expenditure that has been incurred in wrought iron guns and projectiles during the last five years, that the guns now in actual service are the best that could be supplied?—With my present knowledge and experience, I would say, No.

1854. The question of the parentage of the 7-ton gun has arisen, I believe, entirely upon these words used by Mr. Whitworth in his letter of 11th October to the "Times," which says, "The gun differs in construction from the rifled guns of the service. Its metal is differently distributed; its form is different; and it has a fixed breech, being a muzzle-loader." Was Mr. Whitworth justified in making that statement. First of all, is the metal differently distributed, that is to say, that it is thicker over the powder chamber and in other parts, and that the gun is longer than the guns in ordinary use in the service?—Yes, that was strictly true.

1855. He says also that its form is different; is that correct?—I do not say but that that is right, because there are no two guns of the same form.

1856. But is the form of this gun different from that of the ordinary gun in use in the service?—Yes, its precise form is different.

1857. It is a 7-ton 8-cwt. gun, whereas the 7-inch guns in the service are 4 tons?—One is a breech-loading gun, and a different gun altogether; it is quite distinct from the other.

1858. A 7-ton 8-cwt. gun cannot be the same in

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in form as a 4-ton gun?—No; with that explanation it is quite correct.

1859. Then Mr. Whitworth states that his gun has a fixed breech, was that correct?—Yes.

1860. Whereas the guns in use in the service are breech-loaders?—Yes.

1861. Then you consider that Mr. Whitworth's assertion, so far as that is concerned, is strictly correct?—All those points which you mention are correct, strictly speaking.

1862. Then the point which you take exception to is this: "the gun was made to drawings supplied by me," that is to say, by Mr. Whitworth?—That almost contains the greater part of my exception, but I should not like absolutely to commit myself to saying that is all.

1863. The Committee need not go over the evidence which has been already given, but you have defined that although the gun was externally nearly the same, differing only in two inches from that which was originally designed by Mr. Whitworth, which two inches are in dispute between you and Mr. Hulse; in other respects it was identical with the gun originally designed by Mr. Whitworth, so far as the external outline is concerned?—Yes, with those exceptions that I have made.

1864. But you take exception to the statement that the gun was made to drawings furnished by Mr. Whitworth, on the ground that the parts were differently made up in the gun which you manufactured?—Yes.

1865. And that the breech and internal tube were differently constructed?—Yes.

1866. It being a matter of opinion whether the gun as originally designed by Mr. Whitworth, or the gun as carried out by you, was the stronger and better gun of the two?—Yes.

1867. Mr. *Baring.*] I understood you to say on your last examination that this gun was distinctly and positively built on the Armstrong principle of construction?—Yes.

1868. I also understood you to say that the drawing sent by Mr. Whitworth was not on the Armstrong drawing?—Yes.

1869. The principle of construction was different, was it not?—Yes.

1870. And the metal was different; one was to be homogeneous iron and the other of wrought iron coils?—I have been searching to see whether it was so, but I find no letter which says that it was to be of homogeneous iron; it was only from the opinion that I had formed that I stated that.

1871. It has been stated by Mr. Whitworth or his partner, that it was to have been of homogeneous metal; would not that at once constitute a most complete difference in the construction of the guns?—Yes.

1872. In fact, Mr. Whitworth asked you to make a 7-ton 7-inch gun, and you made it upon your system of construction?—Yes.

1873. Mr. *Beecroft.*] Did you and Mr. Hulse come to a mutual understanding with respect to the formation and construction of a 7-inch gun made of 12 parts?—Mr. Hulse gave his sanction to it, and Mr. Hulse discussed the general points in connection with it, and some of those points I modified in that discussion; one of those points was that of the trunnion. I remember Mr. Hulse expressing his views as to drawing $\frac{W}{82}$; he pointed out certain points in that which could be modified, and I agreed with him, and we did so.

1874. Did Mr. Hulse, in his interview with you, understand that the gun was to be made on Sir William Armstrong's principle?—I was fully under that impression; but no words were used that would indicate that; there was nothing said about it.

1875. There was nothing said about Sir William Armstrong's principle, was there?—I do not remember it having been said.

1876. There was nothing said about Sir William Armstrong's principle of construction being involved in the construction of that particular gun?—Subjects of that kind were never brought up. We never spoke about the system. One thing led to another, as matters do in business, and the thing gradually changed from the one into the other.

1877. Did you consider that the principle of the gun had merged into Sir William Armstrong's principle?—Yes.

1878. At the conclusion?—Yes.

1879. And do you think that Mr. Hulse was also under that impression?—I was under that impression; but there were no words which passed to indicate that.

1880. *Chairman.*] The War Department, on the 14th of December, I believe, authorised you to make a gun in accordance with a drawing to be furnished by Mr. Whitworth, and, of course, on his principle?—Yes.

1881. Why was it that you did not make the gun according to Mr. Whitworth's principle?—When I got the drawing I saw several things in it that were, in my opinion, not right with regard to the structure; and I likewise found that it was a more difficult gun to make than the guns we were making. For the various reasons which I gave in my former evidence before this Committee, I thought it would be better for Mr. Whitworth to get another gun of the same size in the bore, but different in construction. Accordingly, I sent him those two drawings, 68 and 69, part of which he agreed to, and part of which he objected to. Then Mr. Hulse and myself considered the drawings and the whole subject, and it finally ended in the lower gun.

1882. But is it not to be presumed that Mr. Whitworth still considered his own principle to be the best, and that he would have wished to have the gun made according to his principle; and is not the real reason why the gun was not made according to Mr. Whitworth's principle stated in a letter addressed to you by the Whitworth Ordnance Company, dated the 26th of December 1861, "Considering that the mode of construction which Mr. Whitworth would have preferred, and which we have explained to you cannot, with the facilities now existing at Woolwich, be conveniently carried out, we will avail ourselves of your offer to undertake the responsibility." Is it not the case that Mr. Whitworth desired to have the gun constructed as nearly as possible according to the drawing which he sent to you, and that the arrangements that were made between you and Mr. Hulse were with the view to discover how nearly your appliances would enable you to construct such a gun?—I say yes, if I understand the question correctly.

1883. Captain *Jervis.*] You were asked by one of the honourable Members with respect to whether those drawings had been submitted to Sir William Armstrong. I think at that time Sir William Armstrong was acting as superintendent

tendent of the Royal Gun Factory, was he not?—Yes.

1884. And you were then acting for Sir William Armstrong?—Yes.

1885. Consequently the sanction which you gave was the same as if Sir William Armstrong had given it, was it not?—Yes.

1886. You having received permission from the War Office to make for Mr. Whitworth a gun on Sir William Armstrong's principle?—Yes.

1887. You have been asked with respect to whether you approved of this particular fashion of making the gun for want of certain facilities, are you aware if there were facilities for making that gun anywhere in England?—No.

1888. At Mr. Whitworth's manufactory, they did not exist, did they?—I am not aware.

1889. You heard him state so here, did you not?—Perhaps so.

1890. Apart from the question of facilities, did you not consider, from your experience, that the gun submitted to you would not stand what was required of it?—Yes; I was under that impression.

1891. And in consequence of that you proposed Sir William Armstrong's plan?—Yes.

1892. I see in the room a drawing of a 12-ton Armstrong gun made in 1861, is not that almost identical with the drawing which you finally adopted?—There is a very great resemblance.

1893. But with respect to the principle, is it not identically the same?—Exactly the same principle of construction.

1894. You have also been asked with respect to the question of the fixed breech. Will you be so good as to look at questions 1200 to 1203. I asked Mr. Whitworth then whether, in the original drawing the intention was to have a solid forged breech piece. Now is there any similarity either in principle, in detail, or in construction, between the breech piece proposed by Mr. Whitworth and the one adopted?—No.

1895. None whatever?—None.

1896. Mr. *Baring.*] In fact there is no piece that you would call the breech piece in Mr. Whitworth's drawing. There is a breech screw, but no breech piece; is not that the case?—There is no breech piece.

1897. Mr. *Vivian.*] Which is the breech piece?—That (*referring to the drawing*) is the breech piece.

1898. You have been asked with regard to the 12-ton Armstrong gun; it is a very full-sized drawing; but there is one remarkable omission; the calibre is not stated; what was the calibre of that gun?—10½ inches, if I remember rightly; this is a gun made at Elswick.

1899. Can you tell the Committee why such a leading feature as the calibre was omitted from a drawing of that scale?—That is the full size; it is just the same as the other drawings; they are all full sized.

1900. Can you, in contrasting guns, contrast a 10½-inch gun with a 7-inch gun?—No.

1901. Mr. *Laird.*] The 7-ton gun as made, was made to your plan and approved of by Sir William Armstrong, was it not?—Sir William Armstrong did not interfere in the matter.

1902. But you were acting under him, were you not?—Yes.

1903. And you approved of the plan, as being the best that you could adopt at that time?—Yes.

1904. Has that gun stood?—No.

1905. Where has it given way?—In the powder chamber, from the unsoundness of the iron (*referring to a model*).

1906. Can you repair that defect?—Not without taking out the barrel.

1907. You would put in a new barrel?—Yes.

1908. Not a lining?—It is a sort of thick lining.

1909. Do you think that that would be an efficient joint?—It would be better to take it all out, and put in a new one entirely.

1910. Then the gun made on the plan which you most approved of has proved defective, has it not?—So far it has.

1911. Major *O'Reilly.*] Is that barrel which has proved defective made of forged iron, on the coil principle, or of homogeneous metal?—It is forged iron, not on the coil principle.

1912. Can you form any opinion whether it might have failed there or not if it had been made of homogeneous metal?—It would not be so likely to fail.

1913. Mr. *Beecroft.*] In your interviews with Mr. Hulse about that gun, did you propose to Mr. Hulse the adoption of Sir William Armstrong's principle?—Mr. Hulse thoroughly knew all about Sir William Armstrong's principle; but we never spoke upon the subject.

1914. Captain *Jervis.*] But he knew when you did speak about it, that it was Sir William Armstrong's principle?—He is quite familiar with our manufacture.

1915. Sir *John Hay.*] Returning for a moment to the question of the durability of the gun, homogeneous metal having been contrasted with the forged iron of which the gun was actually made, let me ask you, in addition, if the gun had been made (as you usually make the guns) on the coil principle, which of the three would have lasted the best?—With the steel of that period, and with the coil and forging of that period, going back to that time, and having to make a choice, I should have said solid wrought iron was best.

1916. In preference to either steel or forged iron?—Yes; but my answer requires the period to be taken into account, because I have since modified my opinion.

1917. You now believe that a homogeneous metal tube would be better than a forged iron tube?—Yes.

1918. But would a homogeneous metal tube be better than a coiled iron tube?—If a coiled iron tube is perfect, it is very good; but steel is better.

1919. Captain *Jervis.*] That change in your opinion arises very much from the manufacture of steel having so vastly improved of late, does it not?—Yes; and more especially from what Krupp is now able to do, beside what we can do ourselves.

1920. Mr. *Vivian.*] What is the difference between homogeneous iron and steel?—None, I think. It is a mere term.

1921. That gun gave way at a weld, in your opinion?—The iron is made of a number of pieces; some little corner had turned up, and then the gas got hold of it, and kept on tearing it more and more.

1922. That was at a weld?—Yes.

1923. The iron is welded from first to last; from the first puddling down to the last process which

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which it can possibly undergo, is not that so?—Yes.

1924. In your opinion it did give way at a weld?—At some portion of a weld it did.

1925. Captain *Jervis.*] How many rounds were fired with that gun?—I do not know.

1926. You have no idea?—I have no idea.

1927. Are you aware what the charge was?—27 lbs. was the highest; not many rounds were fired with that, but a great number of rounds were fired with the 25 lbs. charge.

1928. Are you aware of any cast iron or steel that would have stood a succession of rounds with that charge?—I cannot say I am.

1929. Do you not think that homogeneous iron would have gone quite as quickly?—The chances are very much that the homogeneous iron would give way more readily than the wrought iron would, as a solid gun structure.

1930. You have no data to go upon which would enable you to say that any homogeneous iron or steel, would have stood better than the wrought iron with such a charge of powder constantly repeated?—No.

1931. Colonel *Dunne.*] Therefore there is no gun in existence that would stand those charges?—I do not know of any other gun that would do it.

1932. Then, as that gun did not do it, there is no gun in existence that would stand those charges?—Not that I know of.

1933. Captain *Jervis.*] What was the proof charge used with that gun when you delivered it?—25 lbs.

1934. Do you know of any gun ever made with which we are in the habit of going on constantly firing proof charges?—I do not suppose that any gun up to that time was so severely tried.

1935. Have you ever heard of a gun being constantly fired with proof charges?—No.

1936. Was it not the opinion of everybody who watched that experiment, that the gun must have burst or got destroyed somehow or other?—That was the general opinion.

1937. Mr. *Vivian.*] Did you ever know of a 7-inch 7-ton gun constructed as that gun was constructed?—No.

1938. Is there not a hundred-pounder gun made by Krupp, now at Woolwich?—Yes.

1939. How many times has that gun been fired?—A great many times, and with very heavy projectiles; it is a very good gun, as good a gun as can be.

1940. What is the bore?—Seven inches.

1941. What charge of powder has been used for that gun?—27 lbs. is the proof charge.

1942. But what has been the customary charge with which it has been fired?—It has been fired with a 14 lbs. charge, 10 rounds with one shot; and then the same charge with two shots, and then with three shots.

1943. Mr. *Beecroft.*] From your experience, do you consider homogeneous iron more to be depended on, with respect to the uniformity of quality and texture than steel?—Homogeneous iron is steel; it is a very mild steel; it is a steel with very little carbon in it.

1944. They are two different names, are they?—Yes, but it is only a mild steel.

1945. Mr. *Land.*] If you had now to make that gun would you make it of homogeneous metal?—I would make it of homogeneous metal in the inner barrel.

1946. Then you consider that it is a better metal?—Yes, for that purpose.

1947. But I understood you to say that you could not make a better gun than that?—When that gun was designed I would have chosen solid wrought iron as safer, being afraid to risk the uncertainty of the other material.

1948. Then you have come round to Mr. Whitworth's opinion that homogeneous iron is the best?—I would use it in preference.

1949. *Chairman.*] At the time that that gun was made, was it Mr. Whitworth's opinion that homogeneous metal was the best material for the two?—He has always adhered to that opinion.

1950. Therefore in that particular the gun was made not according to his wish?—He would have preferred the other.

1951. Mr. *Baring.*] Are you aware whether Mr. Whitworth did not write a letter to the War Office stating that he was, as yet, unable to depend sufficiently upon steel to make the gun of steel?—That is very likely, but I do not know.

1952. Captain *Jervis.*] A year ago you stated that you found Krupp steel would only resist a pressure of 25,300 lbs. to the square inch, while the iron you were using resisted a pressure of 33,000 lbs.?—Yes.

1953. But even at that time Mr. Whitworth was for homogeneous iron?——

1954. *Chairman.*] Is there anything else which you wish to state to the Committee?—Yes, with respect to any hesitation which I may have seemed to express about confirming Mr. Whitworth's written statement before this Committee, I should like to say that when the questions were put to me I had not read the statement, and I therefore hesitated in giving it my approval or disapproval; I have since read it carefully, and so far as the historical facts and the whole correspondence are concerned, they are quite in accordance with my views; several words used might admit of two renderings, but as a whole, I concur in those facts.

1955. Captain *Jervis.*] With respect to that statement in which you say you concur, is it the same statement which was shown to you by Mr. Hulse?—It is not the same; I have here the two gentlemen who were present when it was read, and who have read this statement with equal care, and they say that it not the same; there are several differences in it, and there are certain words that they remember having spoken upon, and which are not here, but as a whole it is very like it.

1956. *Chairman.*] Is it substantially the same?—The facts are substantially the same.

1957. Captain *Jervis.*] But with respect to the objections that you took to one paper, are they adopted in the other paper?—With respect to the inferences from the facts, it was never supposed that we agreed upon them, but with respect to the facts you will find that they are substantially the same.

1958. But you do not agree to the inferences which Mr. Whitworth drew from those facts in his statement?—No, I could not have done that, nor could Mr. Whitworth have supposed I had, and for this reason: about a month ago I stated my views of the whole transaction, and I have never altered them in any way. When the statement was read by Mr. Hulse we could not agree to it, and it was taken away for the purpose of being modified, and as the whole thing when read to me seemed to be about the same, and I did not expect to hear of it any more, that would account for

for my having, under such circumstances, concurred in the paper.

1959. With respect to Mr. Aston stating, "I said to Mr. Anderson, 'have you heard Mr. Whitworth's statement to-night?' Mr. Anderson replied, 'Yes; and I agreed with every line of it.' I asked Mr. Anderson, 'Do you consider that Mr. Whitworth's assertion that the 7-inch gun was made according to drawings supplied by him, was contrary to the truth?' and Mr. Anderson replied, 'Certainly not.'" Did such a conversation take place?—When Mr. Whitworth read that paper to me, there was no one present. Mr. Aston said that he spoke upon the subject to me afterwards; if Mr. Aston did so, I have no recollection of it, nor have I any recollection of (and as I have stated) Mr. Whitworth having read that paper, it did not leave any impression on my mind whatever. The decided impression on my own mind is, that Mr. Aston did not speak upon the subject to me.

1960. Mr. *Baring.*] The Committee are to understand that you agree in the main with the statements of fact contained in Mr. Whitworth's paper, but not with the inferences?—No; not with the inferences. I have given my opinion of the inferences in this room before.

1961. But with respect to the facts, you still agree that they have been fairly stated?—Yes; just as they were in my own statement last Monday.

1962. The difference between you being in the inferences to be drawn from those facts?—Yes.

1963. *Chairman.*] In answer to Question 1235, His Royal Highness the Duke of Cambridge, speaking about the sealed pattern gun at Woolwich, says that, "A specification was made, and in the specification there was nothing about lining." Could you put in a copy of that specification?—I will make inquiries, and see if there is a specification. I could not say that I know of it at present; but it may exist in the office.

1964. If there is a specification in existence in your office, you will put it in?—Yes.

1965. In reply to the same question, His Royal Highness stated that he considered it was a most improper thing on the part of the person at the head of the Royal Gun Factory to deviate from the sealed pattern; have you any remarks to make upon that?—I regret that my words should have been put in such a way as to convey that impression to His Royal Highness. What I meant was, that I might make such an alteration as this: for instance, if the metal would not stand at "particular point of a gun," I might shift it a quarter of an inch, that being an alteration that would not affect the structure in the smallest degree. That was the sort of thing that I meant; I did not at all refer to those points where the service is concerned, not to the exterior or the interior of the gun in any way. I trust that with this explanation I shall not be misunderstood upon such a vital point.

1966. But that particular sealed pattern is a lined gun, is it not?—Yes.

1967. Do you consider yourself bound to make all the guns lined guns?—No.

1968. Colonel *Dunne.*] The gun, when Sir William Armstrong took charge of the Royal Gun Factory, was not supposed to be a perfect gun; but he had the right of making such alterations as he liked; is that the case?—I should suppose that that was the case. But Sir William Armstrong did not make alterations without bringing them under the notice of the proper authorities.

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1969. Were those alterations made by the authority of the War Department?—Yes.

1970. He brought them to the proper authority, and received the proper assent?—Yes.

1971. Mr. *Baring.*] At one of your late examinations here, you gave the Committee an account of the defects of three guns, which were sent to you for inspection, and which had failed?—Yes.

1972. With respect to those guns which were reported to have failed on account of the lining, have you received any more guns at the Royal Gun Factory since, and can you give the Committee any further information with respect to those guns that have failed on account of the lining?—I mentioned that 14 guns had come back defective, and that three of those had been found very bad. I said that there was no other gun that had anything the matter with the lining. I was wrong, for I should have said that there was one more gun in which the lining had shifted the tenth part of an inch, and that particular gun is No. 190. With that correction, I having carefully gone into the point again, the matter is put straight.

1973. Mr. *Vivian.*] Will you refer to questions 1263–4 and complete your evidence on that point. You were asked whether Nos. 153 and 250 were lined guns?—No. 153 is not a lined gun.

1974. Is No. 250 a lined gun?—No; that is not lined.

1975. Are those the guns which His Royal Highness the Duke of Cambridge considered from the report of the Committee had been lined guns, and which turn out on investigation not to have been lined?—153 came back to have the powder chamber enlarged from what it was before to 3.2, and the sight was defective. It was enlarged about 2.100ths of an inch of No. 250, the trunnion has moved .01 8, and the outer tube shows a sort of line upon one of the outer coils, a small portion of the weld not being sound; but I suspect it was on account of the trunnion having shifted a little, and the end of the screw being broken.

1976. Does that communicate with the interior of the gun?—No.

1977. Would those injuries have precluded those guns from continuing serviceable guns in action?—I should have supposed not.

1978. Major *O'Reilly.*] As an experienced gunmaker, do you consider that the screwing together, or the welding together of coils is the best mode?—I would prefer welding; but screwing is stronger; I would practise welding for other reasons.

1979. Will you state to the Committee why you would practise welding?—Because it is not so expensive.

1980. Is there any other reason why you would practise welding?—That is the principal reason.

1981. Have or have not most of the defects in the guns occurred in the weld?—Yes; the greater number of them.

1982. Do you consider welding the rings or casting them the better mode of manufacture?—If the cast rings had the toughness of welded rings, I would prefer the casting.

1983. Do you think that they cannot be made

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as tough?—My own knowledge does not lead me to suppose that that has been yet done.

1984. Mr. *Baring.*] I understood you to say in answer to a previous question, that after our large experience in the manufacture of guns, you do not think we have got the best possible gun for the service; what did you mean to convey to the Committee by that remark?—What I mean is, that all the good is in no system, nor all the bad; that if we could only manage to pull together for a short time, we should soon get a good gun, but while we go on each one working for himself on his own system, it is difficult to get at things that will give ultimate satisfaction.

1985. In that respect you have been in communication as assistant-superintendent of the Royal Gun Factory, with Mr. Whitworth and other inventors of systems of rifling, and so on?—Yes.

1986. Can you say whether any assistance has been given to them for carrying out their plans in the Royal Gun Factory?—Everything that we can do for all of them we do, just the same as if it were for ourselves.

1987. So that whatever difficulty there has been in bringing people together, has not arisen from any deficiency of assistance in the Royal Gun Factory?—No; quite the contrary.

1988. Mr. *Vivian.*] But you only speak for your own department?—Only for my own department.

1989. Mr. *Baring.*] Your department being the department from which inventors receive assistance in the manufacture of guns?—Yes.

1990. Sir *John Hay.*] That department being presided over by Sir William Armstrong?—Yes.

1991. Mr. *Vivian.*] The assistance rendered by your department does not relate to trials or the adoption of new inventions?—No, that is not my point.

JOSEPH WHITWORTH, Esq., and WILLIAM WILSON HULSE, Esq., recalled; and further Examined.

J. Whitworth, Esq., and *W. W. Hulse*, Esq.

1992. *Chairman* (to Mr. *Whitworth*).] Is there any statement which you wish to make to the Committee before I proceed with your examination?—Yes; my partner, Mr. Hulse, wishes to put in the statement which he thought had been lost.

1993. (To Mr. *Hulse.*) What is that statement which you now produce?—This is the original statement which I read to Mr. Anderson, which I thought was lost or destroyed. [*The Statement was handed in headed "Mem. for Statement as to 7-inch gun drawings"* (vide *Appendix*).]

1994. Captain *Jervis* (to Mr. *Anderson*).] Do you recognise that paper which Mr. Hulse now produces as the original paper which you saw?—I should think it is.

1995. *Chairman* (to Mr. *Hulse*).] Is there anything else which you wish to explain to the Committee?—Yes; I should also wish to explain that in addition to this written statement, when we came to the points in dispute, that is to say, as to whether the drawing which I then took was similar to the drawing of Mr. Whitworth. I there and then, before Mr. Anderson and Mr. Baker, and Mr. Sandiman, brought to their recollections the pencil marks of the hoop which I had suggested on drawing 68, which had been sent down to us by Mr. Anderson, and I further explained my understanding of that expression "details of construction" and "responsibility to Mr. Anderson," the latter having reference particularly to the closed breech, and to the enlargement of the tube immediately beyond the inner tube, while the details of construction had reference only to the shrinking of the hoops, and making them parallel, instead of screwing them together and making them conical.

1996. (To Mr. *Anderson.*) Have you also a statement which you wish to put in?—Yes, here is a statement made by Mr. Baker and Mr. Sandiman, who were present at the reading of the paper by Mr. Hulse.—[*The same was handed in.* Vide *Appendix.*]

1997. *Chairman* (to Mr. *Whitworth*).] Is there any further statement which you wish to make to the Committee?—After hearing the explanations that have been given to the Committee, I should be glad to know whether the Committee wish me to proceed with my general evidence, and if so, what course they will take with respect to the charges made against my veracity by the Ordnance Select Committee.

The Witness withdrew.
Committee deliberated.
Witness called in.

1998. *Chairman* (to Mr. *Whitworth*).] The Committee have unanimously come to the following resolution: "That the Chairman be instructed to inform Mr. Whitworth that having placed his reply to the report of the Ordnance Select Committee on the Minutes of the Evidence, they do not consider it within their order of reference to decide between him and the Ordnance Select Committee, the question at issue being a matter of opinion. The Committee do not see any reason to question the veracity of Mr. Whitworth's evidence given before this Committee." In July last you addressed a letter to me as Chairman of this Committee, expressing your desire to be examined, as you considered that allusions had been made to you and your system of Rifled Artillery in the evidence given before the committee which would convey a wrong impression unless explained?—Yes.

1999. And you have put into my hands certain questions which you wish me to ask you with respect to that evidence. The first relates to Question 250, where Colonel Lefroy objects to the weight you employ for your gun, especially the 7-inch gun. Have you any observations to make upon that question and answer?—At question 249, he says, "I could mention elements of inferiority. Which gun do you allude to? The Whitworth 7-inch gun, which is 67 cwt. heavier than the 7-inch gun of the service." Instead of that being an element of inferiority, I consider that the 7-inch gun of the service is 67 cwt. too light, and I would appeal to the performance

performance of the two guns, the one being four tons and the other 7 tons 8 cwt. Colonel Lefroy said, also, that he did not know their effects, but by this time he does know.

2000. Then in answer to question 304 he states that the quick rifling turn adopted by you strains the gun excessively. Is that so?—The quick rotatory motion that I think desirable is exerted after the shot has started, and the strain due to the rifling turn increases as the projectile approaches the muzzle, where it becomes greatest. The greatest strain upon the gun is caused in overcoming the *vis inertiæ* of the shot, and would be nearly the same if there were no rotatory motion at all. As soon as the gases are allowed room to expand by the moving of the projectile, the great strain is relieved, and it decreases far more rapidly than the much smaller strain due to the rifling turn increases. Ample compensation is thus afforded for the quickest rifling turn that is required. It has been in the power of the Ordnance Select Committee to obtain the facts necessary to determine positively this point by means of the electric apparatus.

2001. Have they done so?—I believe that they have had that apparatus in their possession for the last three years.

2002. But have they tried any experiments with respect to the question to which you refer?—Not that I am aware of. It is stated that a great strain is put on my gun, in consequence of the great rotatory motion of the shot, and I say that it is in the power of the Ordnance Select Committee to determine that by obtaining the facts.

2003. Sir *John Hay.*] But the object of that electric apparatus of Navey is to ascertain the velocity and not the rotatory motion of the shot?—It will ascertain the former, and also the effect of the latter. Suppose that a gun was made with the slow rotatory motion advocated by Sir William Armstrong, and another gun was made precisely the same in every respect, except that the rotatory motion should be double that of Sir William Armstrong's, which is the rotatory motion that I give, then I would have a third gun the same as the other two, only with three times the rotatory motion of Sir William Armstrong's gun. Now if, after getting the initial velocities, shots were fired from those guns at 500 yards, 1,000 yards, 2,000 yards, and 3,000 yards, you would ascertain the fact whether the quick rotatory motion prevented the range of the gun being what was desired; instead of finding fault with my gun, why have they not tested the fact whether its rifling turn is really too quick?

2004. Captain *Jervis.*] Have you asked them to prove the fact?—I have not, but I should be glad if they had done so.

2005. Have you requested the War Office to look into that point?—No, I have not.

2006. Sir *John Hay.*] Will you be so good as to go back to the question put to you by the Right Honourable Chairman, based upon Q. 250 in Colonel Lefroy's evidence. His evidence is to the effect that for certain purposes the Whitworth 7-inch gun is inferior to the service gun, because it is 3 tons 7 cwt. heavier. May it not be very desirable to have a gun throwing large projectile, and with low charges, for certain purposes of war; I mean guns which are not guns of position, and which it may be necessary to move about?—In reply to that, I would say that the 7-inch service gun is four tons in weight. I happen to have a gun four tons in weight, and 5½-inch in bore; that gun is at Shoeburyness, and the performances of the two guns can be compared. My 4-tons gun will penetrate a 4½-inch plate at 600 yards, but the 7-inch gun, four tons in weight, failed.

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2007. Is it not possible to burn up a larger charge in a gun 7 inches in diameter, than in a gun with a tube of 5 inches?—Yes, my gun had the smaller diameter, and burned less powder, but it produced greater effect.

2008. Then may there not be exceptional occasions on which it may be desirable to use a larger charge, and yet avail yourself of a light gun which you can convey about?—I apprehend that it would be inconvenient for the service to vary the charges very much for the same gun. I maintain that it is better for every gun to be sufficiently heavy, that is strong enough, to bear as much powder being put into it as it can consume.

2009. On all occasions?—As a general principle, I would maintain that it is desirable to obtain the lowest possible trajectory; that is the most important thing of all, and to do that, you must put as much powder into the gun as it can consume.

2010. Supposing I happened to command a wooden ship armed with your guns, and that I was as close to my antagonist's wooden ship as it is possible to get, would you recommend me in that case to use all the powder the gun could consume, and so throw your excellent shell through my enemy's ship?—I think he would be a very bad commander who had my guns, and tried to get into close action; I think he ought to try to get as far away as possible. If close, he should fire a longer projectile.

2011. Mr. *Baring.*] You speak as a manufacturer of guns, do you not, and not as an artillery officer or a naval officer?—I am neither an artillery officer nor a naval officer.

2012. With respect to the service 32-pounders, do you know the different weights of those guns; are they not of very different weights and charges of powder for different purposes?—I presume so.

2013. Do you consider it a wrong system to have guns of the same calibre with different weights and different charges of powder?—I am not aware that with the same gun they use many different charges of powder.

2014. You do not know that?—No.

2015. Mr. *Vivian.*] The quantity of powder which a gun can consume depends upon the calibre, does it not?—Yes.

2016. Then is it, in your opinion, desirable to construct a gun so light that it cannot, from its weakness of construction and want of weight, consume the quantity of powder which is due to its calibre?—I think it desirable that the gun should be made so that it can stand as much powder as it can consume.

2017. You think that the gun ought to be strong enough to carry its full charge of powder?—I think so.

2018. You may subsequently, if you see fit, reduce that charge of powder, of course?—You may, and I would reduce that charge in the case that the honourable Member put to me of being at very close quarters. I would have very long projectiles that would carry a very large bursting

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charge of powder, and sometimes I would have a small charge too.

2019. What you object to is, the construction of a gun which is too light for its calibre?—Precisely.

2020. You say, as I understand you, that your 5½-inch gun weighs four tons, being the same weight as the ordinary service 7-inch gun?—Yes.

2021. And that your 5½-inch gun, four tons in weight, has pierced plates at 600 yards, while the four tons 7-inch service gun failed to pierce them at 200 yards?—Yes, that is so.

2022. Consequently your 4-ton gun, though only a 5½-inch gun, performed the duty which the service 4-ton gun being a 7-inch gun, was unable to perform?—Yes.

2023. Sir *John Hay.*] Was the 7-inch gun unable to do so, because the service charge was so large?—The service charge of the 7-inch bore was 14 lb., and I used 12 lb. for my 5½-inch bore

2024. What was the weight of the projectile?—In my case the weight was from 70 to 80 lb.

2025. And what was it in the other case?—I presume it was 100 or 110 lbs.

2026. Were the projectiles constructed of the same material in both cases?—The Honourable Member knows a great deal better than I do, I presume, that the service gun projectiles are made of different kinds of metal, there being steel shot, wrought-iron shot, and cast-iron shot.

2027. But did not the Committee of which I was Chairman report, you being cognisant of that report, that there was no projectile made of so good a metal as those you had produced?—If they were as good metal they were not so well tempered.

2028. Are you not cognisant of that report?—Yes.

2029. And also that we reported that we thought other guns with the same velocity, and the same description of tempered projectile, would have the same effect?—Yes. With respect to the velocity, the 7-inch bore gun of the service, at 10 degrees, has a range of about 4,000 yards; but with the 4-ton 5½-inch bore gun; at the same elevation a range of 5,000 yards, there again showing the great advantage of having a gun to carry as much powder as it can consume.

2030. No one is denying that. But the question which I asked, and which I should like to repeat, and which meets that question is this; is it not desirable at times to sacrifice that power of consuming powder, in order that you may have a gun of so light a character that you would be able to convey to different positions, which would be almost inaccessible to a gun as heavy as that which you suggest?—But, in that case, I would have proportions such that it would consume as much powder as possible.

2031. Mr. *Laird.*] Have any of your guns been in actual service?—I believe so.

2032. Have you heard of their being in actual service?—Yes.

2033. Have they done well?—I believe they have.

2034. Captain *Jervis.*] Have you taken into consideration what would be the wear of guns fired with those large charges of powder?—Yes; the material must be of the right kind; that, of course, has been our great difficulty.

2035. Therefore, would it not be a very great expense, where guns cost 1,000 *l.* a piece, if they were rapidly worn out with those very heavy charges of powder?—I think we have a material which will prevent their being worn out rapidly, and the guns would not cost 1,000 *l.*

2036. Do you know of any gun which has stood those heavy charges for any time?—We have not hitherto made a larger gun than 5½-inch bore; we are now making them 7 and 9 inches, but we have not completed them yet.

2037. Do you know of any gun which has stood repeated charges of that nature for any length of time?—Not of very large calibre; we have a 3-pounder, which for all practical purposes is as good now as when first fired; and it has fired 5,000 rounds.

2038. Does not a gun's capacity of endurance alter very much as you go on increasing the weight of the shot?—It would, and we fired comparatively very heavy shot from that gun; we fired shot four diameters long.

2039. What was the charge of powder?—One-sixth of the weight of a shot three diameters long; that I have laid down generally as the rule.

2040. Do you take one-sixth as the basis for your large guns?—Yes.

2041. Then, with regard to this 7-inch gun, what would be the weight of the shot there?—150 lb.

2042. And 25 lb. would be the charge of powder?—Yes, 25 lb.

2043. Mr. *Vivian.*] You do not, in fact, use larger charges than the service charges; your four-ton 5½-inch bore gun was charged, I think you said, with 12-lb. of powder, while the four-ton service gun was charged with 14 lb.?—Yes, my four-ton 5½-inch gun was charged with 12 lb., and the four-ton service gun was charged with 14 lb.

2044. Will you contrast again the four-ton service gun; your four-ton gun had a charge of 14 lb.?—Mine had a charge of 12 lbs.

2045. The service four-ton gun was charged with 14 lb. of powder?—Yes.

2046. And your four-ton gun did at 600 yards what the service four-ton gun failed to do at 200 yards?—Yes.

2047. Is there anything in the weight of the projectile which would cause the wear of your four-ton gun with 12 lbs. of powder to be greater than the wear of the four-ton service gun with a 14 lb. charge?—The wear in my gun would be greater, I admit, than it would be in the service gun, from the action upon the bore, because my projectile is longer, and I use one-sixth of its weight, whereas in the service gun they dare not do it; they use shot two diameters long and one-eighth the quantity of powder, and that is the reason they do not get so low a trajectory; but I do not approve of that system. In one case, that of the service gun, there is a range of 4,000 yards obtained at 10 degrees, and in the other case with my gun we get 5,000 yards, so that in action the one gun would be hitting where the other would be missing.

2048. And, moreover, you go through plates which they do not?—Yes, certainly.

2049. Sir *John Hay.*] To make your own answer appear more correct, I think you would add that that is also due to the temper of your metal?—The penetration through the iron plate is due partly to the temper of the shot; but my shot has also the greater velocity.

2050. Marquis

2050. Marquis of *Hartington.*] You do not attribute that penetration entirely to the difference between the two guns, do you?—No, not with regard to the penetration of iron plates; it is as to the velocity that I was speaking; it is known that steel shot were tried ineffectually with the service gun.

2051. Major *O'Reilly.*] Does the service charge of powder in your guns bear the same proportion to the weight of metal in the gun that the service charge of the service guns bears to the weight of the metal?—About the same.

2052. But it does not bear the same proportion to the bore?—No.

2053. Mr. *Baring.*] At what date was that 5½-inch gun made, and was it made at Manchester or at Woolwich?—The first 5½-inch bore gun that we rifled was the service 68-pounder gun.

2054. I allude to the gun, the performances of which you have been describing; there were four made, I believe; two at Manchester and two at Woolwich?—Yes; I thought the Honourable Member meant his question to refer to the first gun that was made of that class.

2055. No, I meant that particular gun; there were four guns made, two at Manchester, and two at Woolwich. Is it the Manchester gun or the Woolwich gun that did the feat you have referred to?—Mr. Anderson made a mistake with regard to those guns. He stated that one gun had been withdrawn, and that the other was damaged in the proof. There was one gun that was very severely proved, and there appeared to be a very slight flaw, and we thought it better to withdraw it. But the other gun remains at Shoeburyness, and that was the gun which Lord Palmerston saw fired when he was down at Shoeburyness with Sir George Cornewall Lewis. That gun has been continually fired from that time up to September last, when we made our first experiment with the four-inch plate, so that there are three of those guns at Shoeburyness.

2056. Of the two guns made at Manchester, one was withdrawn and one has not been experimented on?—One was withdrawn.

2057. And the other gun made at Manchester has been fired repeatedly?—Yes.

2058. Will you explain to the Committee how that gun was constructed; was it made altogether of homogeneous metal, and screwed together?—No, it was made of solid metal; the two, that is the tube and first series of hoops combined in one. It had merely one series of hoops; it was all solid homogeneous metal, with the exception that it had one hoop.

2059. Was the tube made of homogeneous metal?—There was no tube, strictly speaking; it was made in two parts; there was one series of hoops put on the tube.

2060. Was the hoop made by you?—We got them forged.

2061. Where did you get them forged?—(Mr. *Hulse.*) That hoop was supplied from Woolwich, and made by the Mersey Company. The Woolwich people were unable to make the hoops of the size we required.

2062. You obtained that hoop from Woolwich?—Yes.

2063. Mr. *Vivian.*] Being made by the Mersey Steel and Iron Company, and the hoops screwed together?—Yes.

2064. Mr. *Baring* (to Mr. *Whitworth*).] Was not that gun subsequently sent to Woolwich, and further strengthened by hoops?—It was sent to Woolwich to have another hoop put on, in order to give it more preponderance.

2065. Mr. *Beecroft.*] By whose instructions was that done?—We applied in the regular way, and permission was given for it to be done.

2066. Then that hoop was put on by your instructions?—It was put on at our request.

2067. Mr. *Baring.*] Now, with regard to the two other guns; they were made at Woolwich entirely, were they not?—Yes.

2068. What were the tubes?—They were the same as the others.

2069. Were they homogeneous metal?—Yes.

2070. Are you certain of that?—I have always understood so.—(Mr. *Hulse.*) We had a letter to that effect from Mr. Anderson.

2071. (To Mr. *Whitworth.*) In the experiments against iron plates which did you use, the Woolwich gun or the Manchester gun?—The Woolwich gun; the Manchester gun had been used for a long time in making experiments. I did not know the condition of the bore, and I thought it better to use a new gun.

2072. You applied in May 1861 for some coiled tubes from Woolwich for the barrels of guns; what was the reason of that?—We had not got our annealing furnaces of that size erected, and we thought it was better to have an iron tube rather than wait till we got our annealing furnaces erected.

2073. In fact, in May 1861, the manufacture of steel had not so far developed itself that you could rely entirely on it?—We could rely entirely on steel; we only wanted that power of annealing; we had not got the large furnaces.

2074. You could not rely upon the manufacture then, could you?—It is necessary that this homogeneous metal or mild steel should be properly annealed.

2075. Have you sent to Woolwich for trial any five and a half-inch gun made entirely on your own system of construction?—Not made on the system on which we are now making guns.

2076. The system that you now recommend?—The system which I now recommend is to make the tubes of homogeneous metal, and the hoops also. We have not sent a gun to Woolwich, but I was in hopes we should before this have sent some; we are ready to send.

2077. At that time what was the principle which you recommended for the construction of guns?—We recommended a homogeneous metal tube made taper, and the hoops placed on by hydraulic pressure, in the way that upper gun is made (*referring to the drawing*).

2078. I understand that in the upper gun the hoops were made of homogeneous metal?—Yes; but when we had the hoops made of wrought iron, we put them together the same as we now put them together. All our guns have been put together in that way. We have never shrunk them on.

2079. Marquess of *Hartington.*] But those tubes appear to be screwed on?—(*Referring to the drawing*)—The outer tubes or hoops are screwed together, and then put on the inner tube by hydraulic pressure. The bore of the gun is seven inches. The same thing is done with the other series; they are pressed on a little tighter as we get to the outside. It makes my gun look very complicated, showing those hoops in various colours, as in that drawing. In the other gun this

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this tube is made to appear solid; but there is a series of hoops just the same as in my drawing. Each hoop after being coiled and welded, is turned out in the same way.

2080. Mr. *Baring* (to Mr. *Baker*).] Do you recollect how many hoops were sent to Mr. Whitworth for the construction of the 5½-inch gun?—Six.

2081. Were they made in the Royal Gun Factory?—Yes.

2082. They were not obtained from other parties, were they?—No.

2083. Captain *Jervis*, (to Mr. *Whitworth*).] Will you inform the Committee whether in the screwed gun these joints are so united as to become identical in the same way as the welding does?—One is a welded joint, and the other is screwed; and the screw is very much superior to the weld.

2084. But is it not the fact that the screwed joints remain separate, and the welded joints become identical?—In the upper gun, when the hoops are screwed together, it becomes in effect one tube.

2085. Are there no joints there?—There are, but they do not show.

2086. But they do exist?—Yes; and so they do to a certain extent when they are welded together, if the weld is unsound.

2087. But if it is sound, they do not exist?—No.

2088. But in your gun they do exist?—Yes.

2089. Therefore they ought to be shown in one gun and not in the other?—No, I think not; in the upper gun the hoops are forged separate, as in the lower gun, only they are screwed together.

2090. But they become one mass in one case, and they do not in the other?—They are different; in one case they are welded, and in the other screwed.

2091. Mr. *Vivian*.] Do you agree with Mr. Anderson that the screw is probably a stronger attachment than the weld?—I think so.

2092. (To *Mr. Hulse*.) Will you put in the letter which you have from the Royal Gun Factory, stating that the hoops were made at the Mersey Iron Works?—I will put that in.

Lunæ, 4° *die Maii*, 1863.

MEMBERS PRESENT:

Mr. Baring.	Captain Jervis.
Mr. Beecroft.	Mr. Monsell.
Lord Robert Cecil.	General Peel.
Mr. Dodson.	Sir Morton Peto.
Colonel Dunne.	Major O'Reilly.
Marquis of Hartington.	Sir Frederic Smith.

THE RIGHT HON. WILLIAM MONSELL, IN THE CHAIR.

Captain HENRY WILLIAM GORDON, C.B., re-called; and Examined.

Captain *H. W. Gordon*, C.B.
4 May 1863.

2093. *Chairman.*] ON the last day upon which you were examined before this Committee, I asked you to procure certain information, and to produce it to the Committee at some future sitting; will you be so good as to put in any returns which you have been able to prepare in answer to that request?—Yes. First of all I will state, in reply to Question 1013, the sums paid for guns, shells, and fuzes, complained of by the Artillery Committee, of which General St. George was president. I do not myself say that the stores were either obsolete or unserviceable, but the Artillery Committee state that they are so. With regard to the fuzes there can be no question, because they are ordered to be broken up, and their cost has been about 45,000 *l.*; but you would have to deduct from that amount the value of those expended in practice or on service.

2094. Could you not produce a return of those?—It would take a considerable time. The Admiralty have been applied to, as well as the Adjutant General of Artillery. With respect to guns, the Committee in the same way state that they are obsolete or unserviceable. With regard to the shells, there is considerable difficulty. A new pattern was approved before the trials by the Committee, which would, according to their rule, supersede all those that have been previously supplied, and the expense of which would be about 60,000 *l.*; but if they are not all condemned, there would be a reduction of about 10,000 *l.* on that account; the amount of the guns is 45,000 *l.*, the guns and the fuzes being about the same; altogether it amounts to 151,000 *l.*, from which, if you deduct the new coated shell, it gives 140,000 *l.*

2095. Mr. Laird asked you, at Question 1026, "Can you give the Committee the number of fuzes that have been issued altogether of both kinds"?—I hand in a return of old pattern fuzes issued up to this date; the concussion fuzes being 217,458, and the time fuzes being 162,431.

2096. Mr. Laird also asked you, at Question 1031, "Can you say how many fuzes have been issued since the 17th of November 1862"?—I can only say that from Woolwich there have been 1,633 issued for naval service.

2097. Then you were asked, with regard to the defective guns, to give the number made at Woolwich and the number made at Elswick?—There were 362 made in the Royal Gun Factory, and 76 at Elswick.

2098. Colonel *Dunne.*] Those are all defective guns?—No; I do not say at all that they are defective; it is the Artillery Committee that say so; they say that the guns used in the experiments at Shorncliffe were defective; and, in fact, the word *matériel* would include the carriages.

2099. Have you any return to put in, in answer to Question 1037: "You said that the shells were obsolete; can you tell how many shells were issued of the obsolete pattern"?—175,532.

2100. In your evidence on the 20th of April you stated that, up to November last, the Inspector of Artillery still continued to select the guns, whether made by contract, or made in the gun factory previously to the issue of the guns for the service?—Yes.

2101. *Chairman.*] Referring you to the memorandum which I now hand you, from General Tulloh, bearing on that subject, and which is to be found in Appendix No. 24, let me ask whether you can produce any document or give any evidence to show what responsibility was involved in that selection by the Inspector of Artillery?—He examined and selected the guns most certainly up to November last; and every gun, when it was delivered to me by the Royal Gun Factory, was brought over to my department and examined by him most carefully prior to issue. It caused so much expense and inconvenience to the department to be obliged to clean the guns, and to remove the plugs, &c., that I protested against it several times, and said that that ought to be done before the guns were handed over to me by the gun factories. In November last the Director of Ordnance said he was "of opinion that the Inspector of Artillery having been called upon to select the guns for issue, was perfectly justified in refusing to select any guns without first examining them." He continues: "If the Inspector of Artillery has to select them, and be responsible, the guns should be unpacked and their previous history made known to him. I regret that any delay or inconvenience should

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occur, but all this would be avoided if the Royal Gun Factory guns were examined after proof by the Chief Examiner, and officers belonging to the Inspector of Artillery, whose duty it is to select all guns for issue. If the guns cannot be unpacked, the Inspector of Artillery cannot act." And further, in doing away with that selection, he said, "I consent to the guns being issued at once on the responsibility of the Superintendent of the Royal Gun Factory, and the selection on the part of the Inspector of Artillery is dispensed with."

2102. Colonel *Dunne.*] From whom was that order?—It was from General Tulloh, the Director of Ordnance, to Captain Caffin.

2103. *Chairman.*] Can you tell us whether all the guns that have been complained of, and called either patched or lined guns, were inspected by the Inspector of Artillery?—Yes, most undoubtedly; and passed by him as in every respect fit for the service, according to the certificate. I can quote a further instance as to examination on selection: there were 37 100-pounders issued to India last year, and the Inspector of Artillery gave me a memorandum of examination, stating what the flaws were. I sent them to the Inspector General of Stores for India, and the other day I received a further memorandum of the inspection of the same guns from the Superintendent of the Royal Gun Factories. General Willoughby says that the memoranda respecting the guns supplied by the Royal Gun Factory, were not so full in detail as those already furnished, which shows that the Inspector of Artillery had more carefully inspected the guns than the Royal Gun Factory had done, although they were made in that department.

2104. When were those guns issued?—In 1861, most of them.

2105. And finally approved of by the Inspector of Artillery?—They were selected by him.

2106. Captain *Jervis.*] Where are the returns, which you have handed in, made up from?—From the books in my office.

2107. With respect to that return about the fuzes, which were ordered, you say, to be broken up, are you quite positive that they were ordered to be broken up?—Yes, I am.

2108. By whose orders was that done?—By the order of the War Office.

2109. Would you be suprised if the War Office gave orders that many of those fuzes might be used?—The order is perfectly specific; the fuzes are to be exploded at the foreign stations.

2110. Whom is that order signed by?—It was communicated to me by the Director of Stores, but it is written in the name of the Secretary of State.

2111. Colonel *Dunne.*] What is the date of that order?—The 29th of January 1863.

2112. Have any of that class of fuze been issued since for practice?—No; but I believe myself that the Artillery, if the Adjutant General concurs, will use the ammunition that they have at present in the limber-boxes for practice; it cannot be returned until replaced.

2113. And therefore they will use them until they are replaced?—They have no others to use.

2114. Are those returns which you put in similar to what you sent in to the Government, or have the Government required any similar returns?—They have not.

2115. There is nothing more official than what you have handed in?—Nothing.

2116. Referring to the returns you now give of fuzes, to the amount of 45,000 *l.*, has there been any return of that number of fuzes, or how do you calculate the value?—From what we paid to Elswick for the contract fuzes; and for the very few fuzes which were made in the Royal Laboratory, I obtained the value from that Department; I obtained the value of the guns from the Royal Gun Factory, and I took the contract prices for the difference.

2117. Was there any similar return made to the War Department?—No. There was a return called for the other day of the fuzes that had been supplied, and which I have alluded to.

2118. But there was no return made to the War Department of the value of those fuzes that were considered obsolete?—None that I am aware of.

2119. Captain *Jervis.*] Are you aware that that return does not carry out the idea that they were to be broken up?—I am not. I was referring to a request from the Chairman of the Committee to the War Office, to supply a return of the fuzes of the obsolete pattern that had been supplied since the beginning; and that will agree with one of the returns that I have given in. I sent that back to the War Office, giving the same figures.

2120. Will you be so kind as to look again at the copy of the Minute from the Director of Ordnance, in Appendix 24, with respect to the inspection of those guns; and state if it does not seem to be totally at variance with what you now say upon that subject?—I handed in certificates, showing, under the hand of the Inspector of Artillery, that it was as I say. My evidence is all documentary.

2121. If you will refer to that document, I think you will find that it had nothing to do with the original proof?—The first certificate (Paper 22) is with respect to the final proof; the lower Paper (B) refers to the first proof, and it is signed by Mr. M'Kinley and Captain Noble, Assistant Inspector of Artillery, for the Inspector of Artillery.

2122. Then they were still carrying on the first proof?—Yes.

2123. Therefore you make out that that document to which I have referred you, in Appendix 24, is not correct?—I can hand in the original certificate, signed by Captain Noble.

2124. My question has reference to the Minute by the Director of Ordnance, in Appendix 24?—The two differ; but I cannot help that. They materially differ; but the document which I put in is the official document sent from the War Office by the Director of Stores. The Director of Ordnance did not exist at that time.

2125. *Chairman.*] In the report of a "Committee of Artillery officers assembled at the Horse Guards, on the 17th of November 1862, by order of his Royal Highness Field Marshal Commanding in Chief, with the concurrence of the Right Honourable the Secretary of State for War," are these words: "It would seem desirable that all '*matériel*' should be submitted to a careful inspection, other than that of the manufacturer, before being admitted into the service. The guns that have recently failed were all manufactured in the Royal gun factories, and received into the service without passing through the department of the Inspector of Artillery." You distinctly state

state that they did pass through that department?—Yes, and were certified by him to be in every respect fit for the service.

2126. Colonel *Dunne.*] And you received a certificate to that effect?—I assume so from the fact that the guns were finally proved and selected by the Inspector of Artillery, and although the certificate did not give the register numbers of the guns, yet they must have been included in it.

2127. General *Peel.*] You gave a list of a certain number of guns manufactured at Woolwich, and also a certain number of guns manufactured at Elswick, that were called defective guns by that Committee?—Yes.

2128. Why were they called defective; was it because they varied from the sealed pattern?—I could not answer that question; it is a practical question; the Ordnance Select Committee alone could answer that question. I do not say that they are obsolete.

2129. When was the sealed pattern for guns first issued?—It has been changed in its parts five times since it was first sealed; the sealed pattern is not the pattern that was there when the gun was first introduced.

2130. Any guns varying from the sealed patterns would be rejected, I suppose?—They ought to be rejected.

2131. *Chairman.*] In point of fact, the sealed pattern is a lined gun, is it not?—The present sealed pattern did not guide the supply of the other guns.

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2132. But it is a lined gun?—It is a lined gun; I only know that from seeing the examination paper stating so.

2133. The present sealed pattern gun is one of the guns that would come under the sentence of condemnation, pronounced by that Committee?—Yes, but it is against all guns that the Committee pronounce that sentence. The Committee state that the whole of the material is unserviceable.

2134. General *Peel.*] What is the date of the last sealed pattern?—13th December 1860.

2135. *Chairman.*] I have to-day received a letter from Mr. Anderson (in reply to a question I put to him), stating that there is no specification to govern the supply of the 12-pounder Armstrong guns made in the Royal Gun Factory. Do you know whether there was any specification with the sealed pattern?—I can only speak from my own knowledge; all the specifications, sealed patterns, and drawings, pass through my hands; but I have received no approved specifications for any Armstrong guns. There may be a specification that I am not aware of; but I think if there had been I should have seen it, because I should have had to distribute the duplicates of it. *The witness handed in five Returns.*—(*Vide Appendix.*)

The Right Honourable the Earl of LAUDERDALE, K. C. B.; Examined.

2136. *Chairman.*] YOUR Lordship was formerly commander of the "Excellent," I believe?—I was.

Earl of *Lauderdale*, K. C. B.

2137. And you have recently returned from being Commander in Chief of the Pacific station?—Yes.

2138. Had any of the ships under your command in the Pacific station any Armstrong guns on board?—Yes, I think there were three latterly; three 110-pounder Armstrong guns.

2139. Did your Lordship give any special attention to the character and working of those guns?—Yes, I paid attention to them, but we had very little practice with them; we never had an opportunity of practising with them except at sea, where the ship is always in motion, and it is impossible to form any idea of their accuracy, or even to arrive at anything certain with respect to range.

2140. But what was the general impression you formed from your Lordship's own observation, or from the reports which you received from the officers in command of the different ships with respect to the Armstrong guns?—I think I only received reports from two officers; only two of them had arrived before I left the Pacific station, and the reports were what I have stated, that nothing definite with regard to the accuracy or the range could be given from the common practice at sea. If anything, the impression was rather against their accuracy as compared with the 68-pounders.

2141. Will you be so good as to state the particular reasons upon which that opinion was formed, whether by your Lordship or the officers under you?—I can only account for it by saying, that in the Armstrong gun, the shot is rather longer leaving the gun from the time that the line of the friction tube is first pulled; there are two primings to the heavy Armstrong gun, one of them being in the breech piece. I have been absent while all the experiments have been going on with the Armstrong gun, so that I do not know the latest improvements in the fittings; but in the ones I speak of there are two primings, and that occasions the explosion of the powder not to be so instantaneous; and then there may be a difference in the time the shot leaves the gun, owing to the much greater friction: the colour of the smoke from these guns is darker than that from common guns; if this is owing to the fusion of the lead round the shot, it will account for inaccuracy. It is necessary the Committee should understand that at sea the accuracy of the firing does not depend, except in a very small degree, upon the gun; it depends on the skill of the man who fires it, when the firing is at moderate ranges.

2142. Sir *Frederic Smith.*] And it depends still more upon the skill of the man at distant ranges, does it?—At sea, fighting at distant ranges is out of the question, except in bombarding towns, or firing into large batteries.

2143. *Chairman.*] If you were going to take the command of a fleet for active service, would you rather have your ship armed with the old smooth-bored guns, or with the Armstrong guns?—I do not know in what state they are at present, but as far as I have seen them in the Pacific, I would sooner have the old 68-pounders for fighting a naval action, because it must be close, and that gun can throw very nearly the same weight of metal as the Armstrong gun, by double shotting, or shot and shell.

2144. And I suppose it is less complicated also?—The time is rather longer in putting the two projectiles in, but the effect would be nearly equal, but less complicated.

2145. But which would be most likely to go out of order of the two?—The Armstrong.

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2146. In the event of an action being fought between iron-clad ships, would you still prefer the old smooth-bore gun to the Armstrong gun for that purpose?—The Armstrong, I believe, with the common service charge, as now established, is not so destructive to iron plates at short ranges as the old 68-pounder with the wrought iron shot and a 20 lb. charge; of course you must come close to destroy them at all.

2147. Captain *Jervis.*] Your Lordship has no objection to having a rifled gun on board, in case it might be necessary for bombarding at a distance?—I believe that rifled guns (I do not say which is the best) are most valuable for long ranges and for land service, when you fire from a fixture; but it is a totally different case firing from a ship, which is continually in motion.

2148. But if your Lordship wished to bombard a town at some distance from a ship, what would you say then?—Then they would be most valuable.

2149. Are you aware of any rifled gun which you would prefer to the one at present in use in the service?—No, I do not know of any; I have not entered into the subject sufficiently to give a decided opinion, having been away whilst the trials have taken place between the various inventions of heavy rifled guns.

2150. Your Lordship is not acquainted with the experiments during the last two years on board the "Excellent"?—I have read of them. As far as I recollect, it is a question between the Armstrong and the Whitworth gun, and it is not quite clear which is preferable; but (speaking with reference to all built-up guns), if they are frequently fired with very heavy charges, that is to say, charges sufficient to give the shot a greater initial velocity than that of the old 68-pounder garrison gun, with a 20 lb. charge, I think the built-up guns will very soon show symptoms of opening and distress; I do not say that they will burst.

2151. Are you aware whether, on board the "Excellent," the guns were fired constantly and rapidly for a length of time without that result?—I am not aware that they did so with charges amounting to nearly one-fourth the weight of the shot; I do not allude to the service charge, for they will stand a great deal with the service charge, but I am alluding to the charge which would be necessary to destroy an iron plate.

2152. Lord *Robert Cecil.*] I would ask your Lordship whether that opinion which you have first expressed, that if the Armstrong gun were tried with a heavy charge it would probably give symptoms of distress in a short time, is founded on actual observation of any such case?—It is merely my opinion founded upon the comparative results of the Armstrong guns that I have seen fired. You are aware that all the Armstrong guns, or most of them that have been on service, have a certain number of flaws in the bore when they are issued, and a list of those flaws is sent with the gun; after the common exercise with the service charge, I have generally had the gun searched, and I have found that there is a variation in those flaws, always increasing, never decreasing. Those flaws, although they may be immaterial, are defects in the welding, and the firing even of the service charge increases those flaws. Now from that I conclude, that if the gun was fired with the very heavy charge which is necessary for breaking iron plates, the gun must naturally open. The Armstrong heavy gun is composed, I believe, of 10 or 11 different pieces, and however well they may be put together, so closely that you cannot see the join, yet, when the gun is fired with heavy charges, those different pieces, I think, will not continue to expand and contract always to the same amount, and the result would be that there would be a gradual opening.

2153. Which will end in bursting?—It will be a long time before it burst, but a gunner does not like to stand alongside a gun with a few cracks in it. You are aware, with the old gun, that upon the slightest appearance of a crack, the gun was considered unserviceable. Now we are obliged to fire these Armstrong guns with a list of flaws to commence with; but I suppose we shall get accustomed to that.

2154. Do you never have a gun without a flaw?—None of the Armstrong guns that I have seen have been without flaws.

2155. Colonel *Dunne.*] Does your Lordship's objection extend, in fact, to all built-up guns?—Yes; but I am pointing out the imperfection of this gun. I believe the built-up gun is the strongest, but still you cannot look upon it as perfect at present.

2156. Mr. *Beecroft.*] I think you stated that in a naval engagement in the open sea, your Lordship would prefer the old 68-pounder smooth-bored gun to the 110-pounder Armstrong gun; but if an attack were made by a ship against forts, and the ship was in smooth water, so that an accurate aim could be taken, would your Lordship, in that case, prefer the 68-pounder smooth-bored gun, to the 110-pounder Armstrong gun?—If I could insure that the ship would not move, and the gun not disable itself, there is no question about the Armstrong gun being the best, because it would be effective at 6,000 yards or 7,000 yards off for bombarding. But I know that on board ship, even in the smoothest harbour, such as Spithead, the ship is always moving, and the moment you begin to work the guns, every firing sets her rolling two or three degrees. The "Excellent" can be rolled five or six degrees; sometimes the ports are rolled nearly into the water.

2157. Then the least oscillation or rolling of the vessel affects the accuracy of the firing?—Yes.

2158. In that case you always prefer the 68-pounder?—No; I alluded to a naval action which must be close, say anywhere within 1,000 or 800 yards.

2159. Marquis of *Hartington.*] Does your Lordship ever recollect any accident that rendered the Armstrong gun useless for any length of time during practice?—Yes; the breech pieces that were supplied were constantly giving way, that is to say, they cracked; but you are generally supplied with a second one, and the screw sometimes fails. I know there are on record cases of the breech pieces and screws frequently stopping the practice.

2160. Then, in an action the gun would be disabled for some length of time?—Yes; it is more easily disabled than the old gun.

2161. Mr. *Dodson.*] Does your Lordship consider it an advantage that guns on board ship should be breech-loaders, or the contrary?—I think a breech-loader, if you can get it to act properly, and not give way, is a great advantage, and particularly in those turrets; it enables you to have smaller ports, and the men are not

so much exposed. But the breech-loader, in my opinion, for a heavy gun, must be enormously strong at the breech not to give way in time, and at present is far from perfect.

2162. If a ship were to be employed specially for the purpose of attacking forts, would your Lordship in that case recommend the use of the Armstrong gun in preference to the 68-pounder smooth-bore gun?—If you had a sufficiently large mark, I think the Armstrong gun would be an advantage over the old gun, if it did not disable itself, as I could bombard at a very long range, if necessary.

2163. Mr. *Frederic Smith.*] Would your Lordship not consider it a very extraordinary state of things to arm a vessel for one particular kind of service, and not for general service?—Yes; but when an expedition is fitted out for a particular purpose, for instance, to attack forts, I think that the guns ought to be put in the ship for that purpose, the best guns that can be got, not guns for fighting a ship action, but guns for breaching a battery or bombarding at long range.

2164. In the course of your Lordship's long service, do you remember any case in which that has happened?—I do not know of any particular instance in which it has been done, but I do not see at all why it should not be done, and I have always been of opinion that it should be done. I am speaking of the present guns, not the rifled gun; I consider the 10-inch gun for a ship action firing a shell with a 5lbs. bursting charge of powder, as much the most destructive within 600 yards or so, but that gun is comparatively useless for breaching a fort.

2165. And it would not be very serviceable in destroying armour plating, would it?—It would be useless for that purpose.

2166. Therefore, contemplating that the navies of the world will before long be iron-plated, in all probability the 10-inch gun will not be of very great use, you think?—I do. Again, the common gun in our large frigates and screw line-of-battle ships are 8-inch hollow-shot guns. Now for breaching work, or breaking iron plates, those guns would be comparatively useless; and consequently, if I sent those ships against iron-plated vessels or batteries, I should take those 8-inch guns out, and put the same weight of solid-shot 68-pounders in.

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2167. They being of the same calibre?—They being the same calibre, only one is the best breaching gun we have got; the other is comparatively inefficient.

2168. I gather from your Lordship, that if you had to decide upon the armament of a fleet going to sea, you would take a very large proportion of the old smooth-bored 68-pounder guns?—Yes, because I think that up to the present time you have not arrived at a sufficiently perfect rifled gun, there being so many faults found with the heavy Armstrong guns. I am quite aware of their great superiority over common guns, as to range and accuracy.

2169. From your Lordship's great experience in naval gunnery, no doubt you have paid attention to the armaments of the fleets of other powers. Have you any reason to believe that any other power has a more effective gun than we have now?—No; but I think the French rifle gun, which is their old 30-pounder, and throws a 60lb. elongated shot; though it may not be so accurate or quite so long in range, yet for general purposes at sea, on board ship, answers well, and enables them to wait before they decide upon a new rifle gun; in the meantime, it gives them an efficient rifle gun.

2170–72. Is that the old gun rifled, or is it a gun of that calibre rifled?—I believe (I will not speak positively) that several of them, at any rate, are the old guns rifled.

Major General Sir RICHARD J. DACRES, K.C.B., called in; and Examined.

2173. *Chairman.*] WHAT is the strength in the Armstrong guns of the Artillery force at Woolwich, commanded by you?—The Horse Artillery have 24 Armstrong guns, and six 12-pounders of the 9th Brigade.

2174. Before going to Woolwich, what command did you hold?—I was in the Crimea first of all, and before I went to the Crimea I was at Gibraltar.

2175. Were you also in command before Sebastopol?—Yes.

2176. Reverting to what occurred at Sebastopol, can you state generally the number of guns that were used there?—There were 35 13-inch mortars, 35 10-inch mortars, 11 8-inch mortars, 20 5½-inch mortars, 7 Lancasters, 57 24-pounders, 140 32-pounders, 76 8-inch guns, 10 10-inch guns, seven 68-pounders, and three 9-pounders.

2177. And an enormous quantity of ammunition was expended?—Yes.

2178. Were you satisfied or otherwise with the warlike stores furnished to the Artillery and the other parts of the army?—The only things that were defective were a few carcasses that came from Malta or Gibraltar after having been in store a long time, and they failed in consequence of age.

2179. Was there not a Committee appointed, at the end of the siege, to report upon the ordnance that had been in use during the siege?—Yes.

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2180. And the report was very favourable, was it not?—Very much so; the average number of rounds fired from each gun was 1,000, and with some of the 68-pounders a great deal more.

2181. Since you have commanded at Woolwich, has the armament of the Field Artillery been changed?—Yes, to the Armstrong gun.

2182. Do you receive reports of those new armanents from the officers under your command?—The only report I see is that of the officer Commanding the Horse Artillery. His reports are, that he has in the Horse Artillery 66 guns, and he only considers 10 of them to be really effective guns in consequence of the flaws.

2183. They are Armstrong guns, are they not?—They are all 9-pounders.

2184. Have you formed any opinion yourself of the merits of the present service rifled Armstrong gun?—I think it is the best rifled gun known, but I think they have a great many defects.

2185. For field service, would you consider it safe to rely entirely upon them?—No.

2186. Will you state the reasons why you think so?—Because I think that rifled guns are anything but desirable for all purposes. In field service they cut two ways: a rifled gun, if you know

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know the range, is very effective, but if you do not know the range you are infinitely worse off than with the old smooth-bored gun; then, as I think everything connected with it is very complicated, it is a very doubtful case whether it would answer with the very rough usage it would get in time of war. In every Armstrong battery you must have a skilled artificer; if he is out of the way the thing is out of gear, and there are a vast number of small implements that I do not think would ever do in war.

2187. Do you think that the greater accuracy of the gun altogether compensates for the loss of ricochet firing?—Certainly not.

2188. Do you consider that, for garrison purposes, the calibre of guns should be limited?—Yes, I do.

2189. Will you give the Committee your reasons for that opinion?—I think beyond a certain size it is nearly impossible that the guns should be used, unless you employ machinery, which would never do in war. I hear of people firing 50 lbs. of powder; that may do very well at Shoeburyness, when you fire with a galvanic battery, but if you fire the guns over anything, or through anything, my opinion is that the concussion would be too great for anything to stand.

2190. Sir *Frederic Smith.*] You would say that with every battery there should be skilled artificers?—Yes.

2191. Is no effort being made in the Artillery to train the men?—Yes, our men, I believe, are trained for that purpose particularly.

2192. So that you can have a man in each battery?—Yes, you may do that.

2193. On the whole, if you had to decide the armament for the field artillery, you would not select entirely the Armstrong gun?—No.

2194. You would have them in small proportion?—Yes, very small; perhaps I should take a battery of 20-pounders for the particular purpose of reserve.

2195. But for general action, what would you take?—For general action, I should take either the old 9-pounder, 13 cwt., or a gun that is very much used in India, well spoken of, weighing 10½ cwt., which is a 9-pounder.

2196. Have you any means of ascertaining in batteries the distance you are from the object fired at?—That is the great difficulty.

2197. That being the great difficulty, you would rather have a gun that would ricochet?—Yes; it is only a very few days ago that I had a great many officers out judging distances, and there was not one that could judge to 50 yards; and the chances are that you will miss altogether in that case.

2198. Guns of that kind, with their great accuracy, would be much more useful in defending places where you have the exact distances?—Just so. I think that in general action there is nothing to compensate the loss of ricochet.

2199. That is the general opinion of very experienced artillery officers, is it not?—It is the general opinion that I hear.

2200. Captain *Jervis.*] You are not of opinion that there ought not to be a certain proportion of rifled guns employed?—Certainly not; I think there should be.

2201. Are you aware of any better system of rifling than Sir William Armstrong's?—I will give you my exact opinion: my own opinion is, that Mr. Bashley Britten's is the best gun; not his gun, but his shot, which might be fired out of the smooth-bored guns with very little rifling; that is on the expansion principle.

2202. Has he also got a shell?—I believe he has; there is no reason why he should not have a shell.

2203. Take the system as a system, do you think Mr. Bashley Britten's would be better than Sir William Armstrong's?—To my mind, it is the most feasible, being a muzzle-loader. There are many objections to a breech-loader. In the first place, the vent-piece is too feeble for the concussion; in fact, the breeching of the gun has not borne up as well as might be expected. Indeed most of the old artillerymen fancied that it never would have done it.

2204. You do not know of any rifled gun in the possession of any other power which, in your opinion, is a better gun than the one used in the service?—No.

2205. There was a battery of Mr. Whitworth's guns at Shorncliffe, was there not?—Yes, and one went out to Said Pasha.

2206. Do you know that that Shorncliffe battery has been condemned utterly, every gun being completely worn out in nine months?—I do not see how anything else could be expected; but a battery ordered for Shorncliffe does not come under my orders.

2207. Were the guns of that battery brass guns?—Yes.

2208. Captain *Jervis.*] You say that you could not have expected any other results; will you explain your views in saying so?—My views are, that any gun in which the shot has to take turn, iron upon iron or iron upon brass, must be torn to pieces by the shot.

2209. You do not think that, even with an iron gun instead of a brass gun, the result would be much better?—I do not.

2210. Major *O'Reilly.*] You have stated that you consider the present Armstrong gun objectionable, for field service; may I ask whether their being breech-loaders is an essential point in your objection?—No; I was asked with respect to rifled guns.

2211. Do you consider the breech-loader a good gun for field service?—Not those which I have seen; but if the breech, loaders could be made not quite so refined in their formation, I do not know why they should not do as well.

2212. Do you consider the breech-loader more likely to get out of order in the rough work of campaigning than the muzzle-loader?—Certainly; it is more likely many things would be broken off; you have two or three sights, and the screws may get out of order; the old gun was sent down into a ditch or a hole, and even if you did not take the trouble to clean it, it was all right the next day.

2213. In rifled guns would you prefer, if equally effective, the muzzle-loader to the breech-loader for campaigning?—Certainly; I think it is a safer gun.

2214. Are you aware whether any other nation has adopted the breech-loader for field guns?—No, I am not.

2215. You are no doubt acquainted with most of the guns that have been adopted by other nations?—Yes; I believe the French used rifled guns at Solferino, but Marshal MacMahon distinctly said he was very much adverse to them, and did not think them any very great advantage.

2216. But suppose they were to adopt rifled guns, do you think the French would adopt the breech-

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breech-loader for field service?—Not if they could avoid it, I think.

2217. You have stated that our artillery men are now trained to be artificers, to supply the deficiency of men who may be killed in battle; would you kindly state how long it would take to make a recruit acquainted with the duty?—That I could not answer.

2218. Can you state how long it takes an artillery man to train a recruit?—To make him a skilled artificer I could not say.

2219. But to make him sufficiently skilled to handle well the present Armstrong gun, how long would it take?—I do not think there is any difficulty about that, but that is a different thing; the actual firing, and so on, that is very easy; but how long it would take to make a skilled artificer, I cannot state.

2220. In a long war, do you think that the average of the artillery men in the service would have received such training as would make them trained artificers for the purpose of using such guns?—I cannot tell you.

2221. In war would there be a chance of having such men, do you think?—I think not.

2222. Sir *Frederic Smith.*] You are not of opinion that the employment of a man in the trenches for any length of time would qualify him to take the position of a skilled artificer?—Certainly not.

2223. Captain *Jervis.*] But could you not find numbers of men in Birmingham and the manufacturing towns to enlist for that purpose?—That is a different thing, I dare say not.

2224. Marquis of *Hartington.*] With respect to the difficulty in getting at the distance, is not it very easy to get the range at the second or first shot?—If you can see the object, but there is a great deal of smoke and dust.

2225. But if you do get the range, is not the effect of the Armstrong shell much greater than that of any round shot?—Certainly, provided the fuze is good, but I do not think anybody would depend on throwing shells at a very important crisis, unless he could swear that the fuze was as it should be.

2226. What is your opinion of the Armstrong shell?—I have only seen it at Shoeburyness, under most favourable circumstances; the shells have worked most beautifully, but the fuzes have not turned out so well, and at this moment there are no fuzes at all.

2227. Captain *Jervis.*] You mean that they are trying to get a better fuze?—Yes, they are constantly trying, and I have no doubt they will succeed, but the fuzes we had in the Crimea, we could depend on; they were very beautiful, they were the wonder of everybody, they were the old Boxer fuzes that came out during the war.

2228. Mr. *Dodson.*] Has the Armstrong gun been tried in actual warfare, anywhere except in China that you know of?—No.

2229. Have you any knowledge how the guns answered?—There was no very rough work there, they were not thrown into the wet, and remained there for days, and so on, but my brigade major who had a battery of those guns, speaks very favourably of them.

2230. But you do not consider that that was a very severe trial?—No, I do not.

Captain ARTHUR COCHRANE, R.N., called in; and Examined.

Captain *A. Cochrane*, R.N.

2231. YOU are commander of the Warrior?—I am.

2232. I am informed that you have been a longer time than any naval officer the commander of a ship armed partly with 68-pounders, and partly with 110-pounder Armstrong guns?—The armament of the ship was placed on board about September 1861.

2233. Will you state to the Committee your opinion of the Armstrong guns supplied to the "Warrior," whether you consider them safer, reliable and effective guns for arming the navy, and the facts and circumstances that have guided you to the opinion you have arrived at?—On board the "Warrior" we have had no accident with any Armstrong gun; I consider that the proportion of Armstrong to other guns should not exceed one-fourth; that is about the proportion in the "Warrior."

2234. What opinion have you formed with respect to the Armstrong gun?—That it is a very valuable arm to have on board ship, to the extent named.

2235. You mean one-fourth of the whole of the ship's armament?—One-fourth.

2236. What are the defects, and what are the advantages of the Armstrong gun that you have remarked?—The accuracy of their fire and their range are very great; some of the drawbacks to the gun are the danger from the explosion of the cartridge whilst loading, accidents liable to occur to the vent-piece, and the smoke caused by the nature of the powder employed, which contains a larger proportion of sulphur than ordinary powder; the large quantity of grease contained in the lubricating wad, which weighs 2 lb. 4 oz., produces a smoke of so dense a character as to prevent the captains of guns for some time after firing from taking aim, and thereby impairs materially the efficiency of the whole of the remainder of the guns of the ship. The guns are also incapable of ricochet firing, which of course is common to all elongated shot; and as far as my knowledge obtains, they are incapable of parapet firing. Owing to the nature of the powder employed, there is an unusual interval of time after the trigger is pulled before the gun goes off, this has of course a tendency to invalidate the aim. On firing at a floating target, the shot after striking the water are almost invariably deflected to the right to an extent varying from hundreds of yards to half-a-mile; in case it should be requisite to fire over your boats, when making an attack, this would be a great drawback; the lead coating I believe occasionally strips off. Accidents also occur to the vent-pieces; on board the "Excellent" I witnessed, on the upper deck, an Armstrong gun fired about 20 times, in 24 minutes, without any accident; but when firing from one of the Armstrong guns on the main-deck, the vent-piece blew out and broke a beam and started the deck. A gun also missed-fire; the vent-piece had to be withdrawn, and this might have been productive of a serious accident. On board the "Warrior" on several occasions the Armstrong guns have missed-fire; and on very numerous occasions the vent-pieces have jammed in the bore; I imagine this defect is in part owing to the tin-plate which is used in the rear of the cartridge. When the vent-piece is placed in

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in the bore the tin plate interposes at times between the chamber of the gun and the vent-piece, and prevents the latter being at all times efficiently screwed up. In the day time it is easy to see that the vent-piece is well screwed up, but at night quarters it is more liable to accident. On one occasion one of the tin plates was forced upwards from the breech, and a considerable amount of smoke was blown about the deck. The damage which would be inflicted by an Armstrong shell would be very great, owing to the large bursting charge, which is 8 lb., whilst that of the 68-pounder is under three.

2237. Which would be the most efficient weapon against an iron-plated ship at short range, the Armstrong 110-pounder or the 68-pounder?—I have understood there is no doubt that the 68-pounder at short ranges, having a higher initial velocity, would be the more damaging of the two.

2238. What is the reason of the great deflection you speak of?—It is owing to the gun being rifled, the rifling is from left to right over; when the shot arrives at the target, the deflection after striking the water, is to the right. The sights for the Armstrong guns are complex; but they have, I hear, been simplified.

2239. And of course that must affect the accuracy of the aim?—Yes, but there is of course a sight to give the elevation due to the distance, and another to correct the deflection when firing at ranges beyond 1,200 yards.

2240. Do you suppose that in action those sights would be easily brought into operation?—No; and when at sea with the squadron, last summer, we had to abstain from firing, even when firing slowly, on account of the dense smoke caused by the Armstrong guns, which created more smoke and of a worse character than all the rest of the guns.

2241. Did you hear Lord Lauderdale's evidence with respect to the flaws that are always found with the Armstrong gun?—Yes, we have had 19 Armstrong guns on board, in which were 112 flaws, large and small; two of the 110-pounders were returned, on account of the extent of their flaws; in the remainder of the guns on board, the flaws are not prejudicial to efficiency.

2242. In the instructions issued by the Admiralty is there not one referring specially to the Armstrong guns, and desiring the commanding officer to report the flaw?—There is a table furnished showing the number of flaws after firing, and the guns are examined from time to time to see if the flaws become worse in character or increase in number.

2243. Have you found out that they do become worse in fact?—No; but the firing has been of such a moderate nature as not to test severely the guns; for instance, we are limited to five rounds at any one time.

2244. Have you formed any opinion with respect to what the probable effects of those flaws would be in case it was necessary to fire rapidly and repeatedly?—I believe that the flaws would enlarge with constant and heavy firing. The charge has hitherto been 12 pounds, and with that the recoil and strain are considerable. I believe it is now proposed to supply 14 lb. charges, the shot and shell are of different lengths, and when the 12 lb. charge is placed in the gun there is an interval between the rear of the shot and the cartridge of two inches, which is very prejudicial to the working of the gun, because the explosion, owing to that interval, makes the recoil more violent, and if the ship is listed over on one tack, the cartridge has a tendency to get away from the vent-piece, and to cause the gun to miss fire.

2245. What have you found to be the difference between the 110-pounder and the 68-pounder, in precision and rapidity of fire at target practice?—I think the 68-pounder, on the whole, would be a little slower.

2246. Then with regard to precision?—I think that after 1,800 yards the Armstrong gun would be the more precise.

2247. Major *O'Reilly.*] And up to 1,800 yards, what would be the comparative results?—I think below 1,800 yards the 68-pounder would be, perhaps, quite as accurate.

2248. *Chairman.*] Have you observed any, and if so, what difference between the guns at night practice?—I think the Armstrong gun would be more liable to accident at night-time; the greater accuracy of the Armstrong would scarcely come into play if the object were a ship at any distance, at night. Of course, if you were close to the object, the guns would have the same relative advantages and disadvantages that they have in the day-time.

2249. You do not consider that it would be right to have more than one-fourth of the armament of a ship composed of Armstrong guns?—No, I think that one-fourth is a sufficient proportion. It is perhaps worthy of notice that the explosion of the Armstrong gun causes a much greater vibration of the ship's side than the 68-pounders; that the recoil is much more violent, and if the 14lb. charge is adopted, I think it will lead to serious accidents.

2250. Colonel *Dunne.*] On which decks have you those guns?—We have eight 100-pounders on the main deck, and we have two on the upper deck, and four 40-pounders.

2251. Do you approve of the armament in that form; I mean having those guns on the lower deck?—Yes; inasmuch as the ship was not designed to carry such numerous and heavy guns on deck, and the upper works of the ship not being armour-plated, the men and guns would be much exposed.

2252. Do you consider that there is an advantage in arming a vessel with a few heavy guns, instead of having smaller guns in greater number. Will you state the weight of those guns?—I should prefer the large guns. The weight of the 110-pounder is 83 cwt., the 68-pounder 95 cwt.

2253. But would you prefer having more guns with a smaller weight, or a smaller number of those very heavy guns?—The 95 cwt. gun is an exceedingly good one; and, under most circumstances, I should prefer a few large guns to a number of small ones.

2254. You say that the powder causes a more disagreeable smell, than the ordinary powder; is there any difference in the powder from the ordinary Admiralty powder?—The proportions of it are different; the quantity of sulphur is larger.

2255. The powder in the ammunition for the Armstrong gun, is different from that given to ships for other guns?—Yes.

2256. What was the object of that alteration?—I can merely give an opinion, but I believe it was in order that the powder might explode more slowly.

2257. When used as a shell, is the powder the same?—The powder used in the shell is of the ordinary

ordinary kind, but that used in the gun, exploding but slowly, causes, I suppose, a less sudden strain upon the gun and vent-piece.

2258. But that in a shell you think is an advantage, do you not?—The shell has the ordinary powder.

2259. Have you tried any other Armstrong gun?—No, we have only been supplied with the gun in common use in the fleet.

2260. Have you ever seen experiments with any other guns?—No.

2261. Are you aware of any rifled gun of better construction than the Armstrong gun, with all its defects? — Not having seen any practice with other guns I can scarcely give an opinion.

2262. Major *O'Reilly.*] I gather from your evidence that one of the gravest objections to the Armstrong gun is the number of accidents which occur to the vent-piece?—That is one of the objections.

2263. Is not the vent-piece, in fact, the breech of the gun?—It becomes so.

2264. Am I right in concluding that this great objection, in fact, amounts to an objection to a breech-loading gun?—There are objections and advantages in the breech-loading gun.

2265. But does the constant failure of the vent-pieces amount to a defect in the breech-loading gun?—Perhaps I could scarcely say that the vent-pieces have been constantly defective, but they are liable to accidents.

2266. Do you not think that those accidents are liable to occur, even with well-trained men, and with good ordinary care?—I do.

2267. I see it stated in the Report of the Ordnance Select Committee, which has been laid before this Committee, that a number of the accidents which have occurred have been for want of intelligent supervision, and it is also stated that a little common sense seems all that is necessary; from your experience would you not think that a good deal more than a little common sense would be necessary to avoid those accidents occurring from time to time?—I think so, certainly.

2268. Do you not think that with ordinary good trained men, and fair supervision on the part of the officers, accidents to the vent-pieces are still liable to occur?—Yes, I think so.

2269. You have mentioned as a defect in the Armstrong gun the interval which is caused between the charge and the shot or shell, from the difference of length in the shot and shell?—Yes.

2270. Would that defect equally occur in the muzzle-loading gun?—If the guns were not chambered and the shot and shell spherical, they would be forced home on the cartridge.

2271. But taking the muzzle-loading gun; would you have this interval which you have now?—No; but precautions have been taken, when firing from muzzle-loading chambered guns, to use cork tops to the cartridges, and by other means to ensure that the variation in the size of the charges should not cause an interval between the missile and the cartridge; the 68-pounders on board the "Warrior" are not chambered guns.

2272. But would not that be obviated in a more simple manner by the adoption of the muzzle-loading gun?—Yes.

2273. You have mentioned the stripping of the lead coating from the shot as another great objection; would that not be obviated by the adoption of the polygonal system of rifling and the polygonal shot?—I never witnessed any firing with polygonal shot.

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2274. Mr. *Baring.*] Do I understand you to say that you object altogether to the breech-loader as a naval gun?—No, I think the breech-loaders have advantages.

2275. On the whole, which would you prefer, the breech-loader or the muzzle-loader, as a naval gun?—I think that a proportion of both is best.

2276. A proportion of both, in the way of their being breech-loaders and muzzle-loaders, or in the way of their being rifled guns and smooth-bored guns?—I think a proportion of both, whether rifled or not.

2277. Do you apprehend that the men are less exposed with breech-loaders than muzzle-loaders?—Undoubtedly.

2278. With respect to the vent pieces, have those accidents which you have spoken about had any serious results to the men?—Not that I am aware of.

2279. Has anybody been killed?—I have heard of one or two men being killed; I do not know the cases of my own knowledge.

2280. In your opinion, are wrought-iron built-up guns safer than cast-iron guns, or more dangerous to those who work them?—I have seen no accidents with either.

2281. The wrought-iron guns could hardly burst, could they?—I should imagine not.

2282. Mr. *Dodson.*] Is it absolutely necessary to use that slow-burning powder which you have described in the Armstrong gun?—I could only give an answer to that question by inference; the recoil of the gun is very sharp even now, with the 12 lbs. charge, and with the slow-combusting powder.

2283. That slow-combusting powder is always used in the Armstrong gun, is it?—Yes.

2284. Do you suppose that it would be unsafe to use the ordinary powder, and that it would burst the gun or open the gun?—I think it would cause a more violent recoil, and, of course, bring a greater strain upon the gun.

2285. General *Peel.*] You said that one of the advantages of the Armstrong gun was the accuracy of the fire?—Yes.

2286. How do you reconcile that with the deflection which you say amounts, in some cases, to 100 yards, and in some cases to half a mile?—The accuracy of the shot is very great; but after impinging on the water, when it ricochets, its deflection is always to the right.

2287. It is after it has struck the water that the deflection occurs?—It is after the impinging; after striking the water it always progresses to the right.

2288. Where were you furnished with ammunition from?—From various places, originally from Woolwich.

2289. Have any improvements been made in the ammunition?—I believe that improvements have been made in the coating of the shot.

2290. Has any alteration been made in the powder, do you know?—None that I know of.

2291. The ammunition that you have been using is what is now called obsolete, is it not?—No, I have no knowledge that it is so.

2292. Mr. *Baring.*] With regard to the deflec-

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tion of the shot, is that a deflection common to all elongated shot, or is there any peculiarity in the shape of the Armstrong shot?—I think it is simply incidental to the gun being rifled.

2293. And not to the shape of the shell?—I think that the deviation is simply due to the rifling.

2294. From the turn given to the shot?—Yes.

2295. Is that common to all rifled guns?—Deflection would be common to all rifled guns.

Captain F. Beauchamp Seymour, R.N., called in; and Examined.

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2296. *Chairman.*] You have been in command of the Australian station, have you not?—Yes, I was in command of the Australian station up to July 1862.

2297. Will you be so kind as to inform the Committee how many Armstrong guns you had in your squadron?—We had two in the squadron; one on board the "Miranda," an 8 cwt. 12-pounder; one on board the "Harrier," of the same calibre. I had also seen three Armstrong guns of Captain Mercer's battery in action, in field service, between the 15th of March and the 19th of March 1861.

2298. Where was that?—In New Zealand.

2299. First of all will you give us your opinion of the Armstrong gun, speaking from your experience on board ship, and then say what you saw of it in action in New Zealand?—My opinion of the Armstrong gun or any breech-loading gun is, that it is decidedly unsuitable to Her Majesty's service. It has only one advantage that I know of, which is this, that it affords better protection to the persons engaged in loading the gun, than a muzzle-loading gun. In all other respects I consider it is very inferior. My opinion is also based on conversations I have had with French naval officers, who as scientific persons, and particularly with regard to knowledge of gunnery, are our equals in every way. I also know that on board the American navy, there is not at the present moment, either on the Federal or I believe on the Confederate side (but not on the Federal side certainly), one single breech-loading gun. I consider the opinions of the Americans, on matters of gunnery, to be most valuable. One of the defects of the Armstrong or any breech-loading gun may perhaps be estimated if I read to the Committee a letter which was addressed to me by Captain Sir Malcolm Macgregor, Commander of the "Harrier" in December 1861, written under the following circumstances:—In September 1861, I sent Her Majesty's ship "Harrier" up to the "Fijis," with instructions to her commander to levy a fine on the inhabitants of Kinoya, in the Island of Viti Levu, who had been guilty of robbing and ill-treating certain British subjects. I told him to allow a certain time for the payment of the fine, and then if it was not paid, to burn the town down, as he could not take prisoners. He carried out my orders, and previously to landing his men for the purpose of burning down the town, he very properly commenced to clear it by shelling it from an Armstrong 12-pounder, mounted in the "Harrier's" pinnace. At the third round the breech piece came out. It severely wounded Mr. Pritchard, the British Consul, who was in the boat; wounded No. 1 man very badly (entirely destroying the sight of one eye), and slightly wounded Mr. Sedmond, the master of the "Harrier," who was in command of the pinnace, and five other men. The consequence was, and I speak quite advisedly, that there was a sort of feeling on board the ships in Australia of distrust of those guns, and for that reason I supplied the "Harrier," as soon as I possibly could, with a 12 lb. howitzer, as I had previously done the "Miranda." The advantages of the Armstrong gun are these, as far as I have seen, that when your object is distant, above 1,500 yards, and you have got the range, it is a very accurate gun when it is fired on shore, or where the gun is not subjected to a rolling motion. In practice, carried out under my own inspection on board the "Miranda," I have seen the Armstrong gun, when the ship was rolling, not nearly so accurate in its performances as a 68-pounder.

2300. And that is on account of the motion of the ship?—Yes; the difficulty is in getting the range on board ship, for the least motion puts the Armstrong gun out much more than it does the smooth-bore gun. There is also another disadvantage of the Armstrong gun. On the 6th of March 1862, having previously had reason to believe that the Armstrong shot stripped a good deal, I landed two 12-pounders, 8 cwt., Armstrong guns on Garden Island, Port Jackson; the wind was blowing across the range very lightly indeed, and we fired 14 rounds at 1,370 yards. Out of those 14 rounds, three shots stripped in such a way as to look more like canister falling on the water than anything I ever saw before. The shot had been carefully kept in the boxes in which they were supplied, and no reason that I know of can be assigned for their stripping in the way they did. My reasons for having that practice I have already stated. But I may add that, in March 1861, while the force under General Pratt was attacking the Te Are Pa, near the Waitara River, in New Zealand, I was in the advanced sap, when a fire was opened over our heads from an Armstrong gun, mounted in a redoubt about 600 yards in our rear; and that, on that occasion also, some of the shots stripped, the metal from which fell about the sap in a manner which might have endangered the men at work in the sap and in the trenches.

2301. *Chairman.*] Now, will you be so kind as to state to the Committee the result of your observations of these guns on shore?—The Armstrong guns were landed on the 13th of March 1861, and were brought on shore in the boxes in which they had been sent from England with the utmost care. They were taken to the front on the morning of the 15th of March, and placed in and near a redoubt which had been previously constructed. As nearly as I can recollect, this redoubt was 780 yards from the pa we were attacking. From having heard what the Armstrong guns had done in China, we had formed the most favourable opinions of their efficiency, and I can only say that after witnessing the practice from them on the 15th of March, the general feeling was one of disappointment, in which officers and soldiers of the Line, the officers and men of the smooth-bore battery of the Royal Artillery, and those of the Naval Brigade, shared equally; for it was seen that the firing was not so accurate at that distance as we thought we had reason to expect; and even after the range was obtained, which was not without some difficulty, the firing was not superior

superior in any way to that from a brass 9-pounder 13-cwt. gun worked by the Royal Artillery. There is another illustration which I may give: about 10 days before the Armstrong guns had been landed, the enemy made a sortie, broke down the head of the sap, carried off the sap-rollers, and stuck one of the sap-rollers across the only place by which we could get into the pa, in derision, as it were. General Pratt was most anxious to knock it away, as the enemy were excavating a rifle-pit behind it, and he asked Captain Mercer and me to try what could be done with our respective guns. The best shot we had amongst us fired three rounds. I fired three rounds. Six rounds were fired from the Armstrong guns, and not one shot out of either of the guns hit the sap-roller itself. That showed that the Armstrong guns were, at least not on that occasion, superior to the 8-inch 52-cwt gun. I dare say what I am now stating respecting the practice from his battery will be found to differ in great measure from the report of Captain Mercer, which is published in the artillery papers of about December 1861; but I am quite sure that I am only repeating what was the general opinion at the time.

2302. Can you state how many rounds were fired from the Armstrong guns?—Not any large quantity; there were never more than four or five rounds in quick succession fired at a time. I cannot give you the number even approximately, but there was not a large quantity by any means.

2303. Were any of those guns disabled?—No accidents occurred to the Armstrong guns on that occasion, but shortly after the battery was brought up to Auckland, there was a case. I will now read the letter which I referred to: "Harrier, Auckland, 7th December 1861. Sir,—Referring to my letter of proceedings, dated 8th November 1861, in which I mentioned that the vent-piece had been blown out of the Armstrong gun, I have the honour to inform you, that, upon reflection and inquiry, I can only arrive at the conclusion that either the cartridge was not quite home, or that something prevented the vent-piece from dropping close down into its place. I myself heard the cams tap, and the sound appeared correct, although the cone could not have been accurately in its seating; the breach screw must have been very tightly screwed up, because the shot was projected, and therefore the vent-piece must have stood a very severe strain before quitting its place. Captain Strover, R.A., when he came on board to examine the vents of our broadside guns, told me that a similar accident had occurred on two occasions to the Armstrong guns (in New Zealand)." I knew that case; it was on the same day that the two vent-pieces came out. "As at present fitted, I have no doubt when in its proper place no accident can occur; but the smallest inaccuracy, so as to be almost imperceptible, is likely to be attended with serious consequences. With a view to rendering accidents less frequent, I would suggest whether it would not be possible to fit the vent-piece in such a manner, that if it were not properly screwed up, anyone would immediately observe it. I have the honour, &c., *Malcolm Macgregor*, Commander. To Commodore Seymour, C.B., Commanding Australian Station."

2304. Is Captain Mercer now in this country?—No, he is in the command of a battery in New Zealand.

2305. Have you any other observations to make to the Committee?—I would also mention, that I consider the experiment which we are now making in arming our ships with a large proportion of rifled ordnance to be one of a most interesting description in every way, which may be of great benefit, or the reverse, to our Navy. I have never yet heard, either on board the "Excellent," or on board of any other ship armed with heavy guns, of 20 or 25 rounds having been fired in quick succession from Armstrong heavy guns with the service charge, and six or eight degrees of elevation; and until that has been done, and rapid firing has been kept up at night quarters, I do not believe that we are in a position to pronounce a favourable opinion of the Armstrong gun.

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2306. Did you hear the Earl of Lauderdale's opinion with respect to flaws in the Armstrong gun?—Yes.

2307. Have you any remark to make upon that subject?—None, because with us there were so few rounds fired, and no rapid firing (which has more to do with it, perhaps), that I do not think the flaws could have been increased.

2308. Colonel *Dunne*.] What was the weight of those guns?—Eight hundred weight.

2309. And what was the charge of powder employed?—One pound and a half of powder. It was a 12-pounder Armstrong gun.

2310. Were any of those guns fired at all?—Yes, in the battery in front of that pa we had two 10-inch mortars, an 8-inch mortar, a 24-pounder howitzer, and a 9-pounder gun. Those were all worked by the Royal Artillery. We had two 8-inch guns of 52 cwt., worked by the Naval Brigade.

2311. Were any of the guns worked by the Royal Artillery themselves?—Yes; three Armstrong guns were worked by Captain Mercer's battery of the Royal Artillery, and two of the mortars were worked by them. The other mortars and the guns were worked by a detachment of the Royal Artillery, who had been long in the colony, so that we had guns worked by the newly arrived battery, by the old battery, and by the Naval Brigade.

2312. Was Captain Mercer satisfied with the gun?—I think he was very well satisfied indeed, but he was the only one who was.

2313. Did you fire shells?—Yes, concussion shells, and time fuze shells.

2314. And you did not think the results satisfactory?—They were not so satisfactory as we expected. Doubtless we expected too much, because we had heard such wonderful accounts of the efficiency of the Armstrong guns in China, particularly in the attack on the Taku Forts. I recollect on the 15th of March 1861, calling the attention of Lieutenant Picard, R.A., who commanded the right hand gun, to the comparatively indifferent practice made from it, and his replying that it was owing to the right wheel of the gun having sunk deeper in the mud than the left one, on which I said that that sort of thing must always occur on service, and it being impossible to lay down platforms for field guns, I thought the instance we were then seeing was a very fair test of what the Armstrong guns were.

2315. Did any accidents occur with that gun?—No; but our firing was remarkably slow.

2316. Were the guns fired with only the common service charge?—The common service charge.

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2317. Sir *Morton Peto.*] When the vent-pieces blew out, were the guns fired with the common service charge?—Yes.

2318. Was the effect of it that there was any timidity occurring among the men as to the use of that gun?—No; the men themselves would have gone to the gun the next moment; but the effect of it was such as might be produced on the mind of a man, who, having purchased a pair of guns at the commencement of the shooting season, had had one of them burst in his hand the first day he went out shooting.

2318*. I was not imputing any cowardice to the men, but merely suggesting that they might not work the gun with same freedom and ease?—I think that was the way of it. I know a most melancholy case in point, though it has nothing to do with Armstrong guns. About three years ago I had an officer killed, and four or five men and an officer wounded, by an explosion of a shell rocket in the rocket tube, and the effect was a distrust of shell rockets ever after.

2319. They had not the same confidence in them?—No.

2320. Mr. *Baring.*] Was 750 yards the farthest distance at which you ever fired on shore in your practice with the Armstrong guns?—It was the farthest at the place we were sapping up to, but we dispersed some men on a hill above it on one occasion, at a very long range, over 2,000 yards, I think; the shell sent them away immediately. My impression was, that for anything under 1,500 yards, the accuracy of the Armstrong gun is certainly not superior, and may be said to be in a slight degree inferior to that of the smooth-bored 9-pounder brass gun.

2321. And over that distance you think it is superior?—Decidedly so on shore.

2322. When afloat you object to breech-loaders whether rifled or smooth-bored?—Whether rifled or smooth bored.

2323. Apart from that point would you prefer a rifled or a smooth-bored gun?—I think we might take a lesson from the Americans. The subject of the armaments of foreign navies has been a subject of great interest to me since I was a boy of 13. The largest wooden frigate the Americans now have, mount only three rifled guns each; on board the "Wabash" the rifled guns (and they are all muzzle-loaders) are one Dalhgren 80-pounder, one gun of about 40-pounds calibre, made by whom I do not know, and a 20-pounder Parrott gun; on board the next class ship, the "Hartford," there are only two rifled guns, one is an 80-pounder and the other is a 20-pounder Parrott gun; all their guns are muzzle-loaders. In the case of the "Wabash," she has 48 guns, and 45 are smooth-bored, while three are rifled. In the case of the "Hartford" there are 24 9-inch smooth-bored and two rifled guns.

2324. And you think that a good proportion, do you?—Yes, I think it should be just about that proportion; if they are to be breech-loaders I would have them all on the upper deck, because I know, not from my own knowledge, that the escape of gas causes a most serious inconvenience where they are between decks; my authority is a lieutenant who served with me for three years, who is now in the "Emerald," where he commands the quarters in which the Armstrong guns are; and I have heard the same thing from many other officers.

2325. Have you met in any French ship of war with any 32-pounder cast-iron rifled gun?—Yes, it is a very good gun; it is the old 30-pounder No. 1, weighing about 56 cwt.; it is the old gun rifled, and with a large breech-piece shrunk over it.

2326. With a hoop, in fact?—It is much larger than a hoop; the piece shrunk on extends very nearly as far as the trunnions.

2327. Do you know whether the French used those guns as ordinary broadside guns? I am told they are arming very fast in that way. In Port de France, in New Caledonia, two-thirds of their spare shot are for rifled guns.

2328. And what do they say of it?—They spoke of those guns in the highest possible terms, and expressed their surprise that we did not know of their system of rifling, &c. Captain Blakeley's system is something of that kind.

2329. Do you know what charge of powder those guns will stand?—They throw the 60-pounder conical shot; and I do not think they will bear above 5 lbs. or 6 lbs.

2330. *Chairman.*] Are they cast-iron guns?—Yes.

2331. Mr. *Baring.*] Should you be afraid of going into action with only muzzle-loading guns?—Certainly not. To the best of my belief you can load three rounds quick-firing with a smooth-bored to two with a rifled gun. I remember what occurred with the Lancaster guns on board the "Lynx," at Kinburn; both were rifled guns of 95 cwt., and both of them burst.

2332. Do you know whether any of those French guns have burst?—I am told they have; but I never heard of those 30-pounders having burst. On board the "Montebello," a fortnight ago, their new rifled gun burst. I imagine the difference may be in a great degree ascribed to the principle which the French adopt, of shrinking a very heavy breech-piece over the breech itself.

2333. And using very small charges?—And using very small charges. The regular charge for a smooth-bored 30-pounder, No. 1, would be 11 lbs. of powder, which is one-third of the weight of the shot; and the shot weighs 33½ lbs. English.

2334. Those French guns would, I suppose, have great advantages over the same guns before they were rifled?—Yes, I think they would for distant firing, and, on the other hand, at short range they would lose something.

2335. The effect would then be less on account of the charge being smaller?—Yes, for penetration; besides, I have no faith indistant firing at sea. Anybody who has ever exercised the heavy guns of the present day at sea, must know that even in the fairest weather it is useless to fire at any distance over 1,500 yards.

2336. Mr. *Dodson.*] Does that apply to firing at a fort?—I will not say that it applies to any large object like a fort, but in 1854 I recollect that we fired a great many shot and shell at a place in the White Sea, at a range of about 1,400 or 1,500 yards; I do not believe we did any damage at all.

2337. That was at a monastery on high ground?—Yes, a strongly fortified one, mounting guns.

2338. Mr. *Baring.*] Those guns were not rifled?—No; ours were 68-pounders and 32-pounders, nine-teths of them the latter.

2339. General *Peel.*] The guns which you saw in action on shore were under the charge of the Royal Artillery, were they not?—Yes.

2340. An official report was made of their performance, of course?—Yes.

2341. An

2341. An official report was made to the authorities here of the manner in which the guns acted?—I have no doubt that a report must have been written either in April or May 1861.

2342. With regard to your own guns; you made an official report to the Admiralty of the manner in which they acted, and your opinion of them, I suppose?—I did, after the practice on Garden Island.

2343. Of course you are aware that every vessel is armed by the Admiralty?—Yes.

2344. Therefore you have, no doubt, expressed a very strong opinion as to what experiments you think should be made with those guns?—The only guns I had were two guns of light calibre, 12-pounders. I reported to the Admiralty what I thought of them, but I never saw a heavy Armstrong gun until I saw the 110-pounder on board the "Orpheus" at Sydney, in July 1862. Of course, I have learnt a great deal since I came to England.

2345. But you have made an official report with regard to the guns you had?—Yes; and you will find in Captain Mercer's report a great deal that differs from my opinion.

Capt. *F. B. Seymour*, R. N.

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2346. *Chairman.*] Did you make a report of that action at Fiji?—Yes.

2347. The Marquis of *Hartington.*] What was the effect of the shell that you saw fired at the pa in New Zealand, when the range was accurately obtained?—We had not an opportunity of judging well, because the guns were all fired principally at the enemy's rifle pits, and it was the object to drive the shells into the pits themselves.

2348. So that you could not see the effect?—No; the palisading of that pa was nothing at all.

2349. But you did not observe any destructive effects from the Armstrong shell?—I had no opportunity of seeing, but I thought the most efficient weapon against rifle pits was the Cohorn mortar.

Jovis, 7° die Maii, 1863.

MEMBERS PRESENT:

Mr. Beecroft.	Major O'Reilly.
Mr. Dodson.	Sir Morton Peto.
Colonel Dunne.	Sir Frederic Smith.
Sir John Hay.	Mr. Vivian.
Marquis of Hartington.	General Peel.
Captain Jervis.	Mr. Baring.
Mr. Monsell.	

THE RIGHT HON. WILLIAM MONSELL, IN THE CHAIR.

JOSEPH WHITWORTH, Esq., re-called, and further Examined.

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2350. *Chairman.*] In his evidence before this Committee, General St. George said, in reply to question 2732, after giving some detailed results with equal weight of shot, equal charge, and equal length of gun, that the Whitworth 12-pounder will give an initial velocity below that of the Armstrong gun; has that experiment been tried, and are you able to give the results to the Committee?—Some experiments have been made, but not under strictly comparable conditions, the different areas of the two bores not having been taken into account. In the Armstrong breech-loader there is no windage; in mine there is windage for easy loading and the ignition of the shell. But although this is the case, I believe the initial velocity, if under otherwise strictly comparable conditions, would be greater in mine, owing to the retardation by friction being less. In the Appendix to the Report of this Committee for 1862, at pages 270–1, which relate to initial velocity experiments, the first paper put in by General St. George shows a record of experiments made at my request, as I wanted to show that the initial velocity of a spherical shot from a smooth-bored gun would not be as great as from a spherical shot from a rifled gun, and also to prove that the power or the work done is greater from a shot of 3 diameters long than from the spherical shot, even at the muzzle of the gun. At page 270, in the same Appendix, the initial velocities are given, and the weights of the shot. Taking the Whitworth 12-pounder breech-loading gun and the projectile, the first is 3½ diameters, and the weight of the shot is $14\frac{58}{100}$ lbs. The initial velocity is 1251. I multiply the weight of the shot by the square of its velocity, and the result representing the power of penetration is 22,813,000; the next, which is 3 diameters long, gives a power 22,008,000, the next being 2½ diameters long, gives 21,475,000, the 2 diameters long gives 21,497,000, the 1½ diameter long gives 22,036,000 lbs. I would observe that in these there is more powder in proportion. And in the case of a spherical shot, although it gives a velocity of 2,200 feet, the work done is only represented by a power of 16,659,000 lbs.; the weight of the shot being multiplied into the square of the velocity. "The Ordnance Select Committee having stated that, in their opinion, spherical shot would be most effective against iron-plated ships at very short ranges, and this opinion having also been expressed by Ministers in both Houses of Parliament, I thought it was highly desirable to show by experiments what were the facts."

2351. Captain *Jervis.*] Will you give the date when those statements were made with respect to the spherical shot being better against iron plates?—I have not got the date.

2352. Will you put that in?—Yes.

2353. You are aware that, considering what has gone on during the last few years, it is very material to be particular with regard to dates in these matters?—No doubt.

2354. *Chairman.*] General St. George, in answer to question 2700, in his evidence of last year, speaks of a report to be made on experiments witnessed by him at Southport in 1860; have you got that report, or can you tell us anything about it?—No, I never saw that report, but presume that it must have been favourable, for the ranges at different degrees of elevation were greater than I believe were ever obtained before.

2355. Do you mean to say that that report has not been put into your hands?—No, I have never seen that report. There was a report furnished to the late Lord Herbert, and in an interview I had shortly afterwards with him, he mentioned that he had had a favourable report, and wished to treat for my guns.

2356. In answer to questions 2711 to 2713, General St. George states that there had been a report unfavourable to your gun made by a French scientific committee of artillery officers; have you seen that report, or do you know anything about it?—General St. George must have been misled by incorrect information. I caused special inquiry to be made to ascertain whether any such report had been sent in by any committee, and was told that no such report had been

been made. My information was obtained directly from the French officer who had the superintendence of the trials of my guns in France to this effect. I will read a translation of an extract from a letter of the French artillery officer, who had the charge of the Whitworth guns tried in France.

2357. What was his name?—He is an officer who was appointed to take charge of the experiments.

2358. By whom was he appointed?—He was appointed by the Emperor.

2359. Was he appointed specially for this particular purpose?—Yes.

2360. Have you not got his name?—No.

2361. Will you put in his name?—Yes. That letter, which is dated the 3d July 1862, says:—"The Whitworth guns were obtained upon the initiative of the Emperor, and not on the advice of the Committee of Artillery. The commission which has fired them had nothing else to do but to state the results of the firing, and these results have not been submitted to any decision of the Committee of Artillery. It is not correct to say that the Whitworth guns have been rejected in France."

2362. Sir *John Hay.*] Were those guns part of the ordnance used in the French service?—They were experimental guns.

2363. Have they been accepted as ordnance by the French army or navy?—I cannot say what is now being done with the guns.

2364. But have you made any guns, except those experimental guns, for the French services?—No.

2365. *Chairman.*] You have got in your hand the evidence of Sir William Wiseman, given before this Committee?—Yes.

2366. Will you turn to questions 136, 137, 139, and 140, and tell the Committee whether you have any observations to make upon them?—At No. 136 the question was put, "Do I gather correctly from you that it was through Mr. Whitworth's own act that his gun did not receive a larger amount of your consideration than it did?" And he says, "Certainly, inasmuch as we found a great difficulty in obtaining ammunition of any sort." Now I am prepared to say that, so far as we were concerned, there was no difficulty in the matter at all; we were ready to supply shot and hollow shell to any extent required; and I will put in a letter to show that at that time they had plenty of shot and shell.

2367. But was the shot and hollow shell, without any other projectile, sufficient to test the merits of your gun?—Undoubtedly, so far as accuracy and range were concerned; it was not necessary to put a fuse into the shell.

2368. Captain *Jervis.*] Am I to understand that the system which you brought before the Select Committee was one only of a gun, that is to say, a gun with regard to its endurance, or what was the system?—At that time I brought the gun with a solid shot and hollow shell before the Committee.

2369. That was the whole of the system?—Certainly; I never proposed any fuse at all.

2370. Mr. *Vivian.*] I believe your hollow shell was adapted to the ordinary fuse of the service?—Yes, there was windage in my shot, which allowed the old fuse to be readily employed. In Sir William Armstrong's there was no windage; he had to supply a particular fuse.

2371. Captain *Jervis.*] But you are aware that as far as a system of artillery goes, you must take into consideration the Shrapnel shell and fuse, as well as the solid shot?—Undoubtedly.

2372. You did not bring that before the Select Committee; you restricted yourself to the gun having solid shot or hollow shell; is that so?—Precisely.

2373. *Chairman.*] Have you any further remarks to make upon that question?—Sir William Wiseman says, in continuation of his answer, "I never saw myself from that gun a shell with a fuse or a bursting charge of powder fired; there were no Shrapnel shells or other projectiles. We tried solid shot and the same description of shot lengthened with a hollow in it for confining the powder, but we never had a fuse for it." The next question is, "But if you had gone to Mr. Whitworth's factory, would you not probably have been able to try the gun in a better way, and seen more of those things?" and he says, "We could not have tried the gun at all at his factory; Mr. Whitworth, in a letter to us, informed us that he did not propose any particular fuse or any particular description of Shrapnel shell." Question 138 is, "That would appear, I presume, in the letters which you will put in?" and he says, "Yes." Question 139 is, "In that case you had no means of ascertaining the relative merits of Mr. Whitworth's and Mr. Armstrong's guns?" and he says, "With regard to the range and accuracy with shot and shell, we had every opportunity of judging; we fired a great many rounds with Mr. Whitworth's gun, and you will find the results are exactly laid down in the Report of the Committee along with a diagram. But we could not test his shell as a live shell, because there was no fuse for it, and we could not test it as a Shrapnel shell because he never proposed one."

2374. And that is all strictly accurate, is it not?—The latter part is all perfectly accurate.

2375. Captain *Jervis.*] But in order to test one system against another, was not that a very important matter for the Committee to take into consideration?—I expected that they would use the ordinary fuse of the service.

2376. You thought the Committee were going to make a shell to suit your gun, did you?—No, we made a shell ready for the fuse, but not the fuse.

2377. Do you mean the common ordinary bursting shell or a Shrapnel shell?—The common shell.

2378. Therefore the Committee would have had to construct a Shrapnel shell to suit your gun?—Yes, to the extent of putting the old form they had to the shell I supplied.

2379. Do you call that bringing forward a system for trial before the Ordnance Select Committee?—No, I do not call that bringing forward a system.

2380. Were they also to construct a fuse for you?—It was already constructed.

2381. What fuse was it?—It was the common fuse of the service; there was windage in my shell, by which means the ordinary fuse could be ignited.

2382. Did you propose to them to use the common fuse of the service for your shell?—That was understood.

2383. Did you leave that for the Committee to understand, or did you tell them that your shell was for that purpose?—It was well understood that the ordinary fuse would be applied.

2384. Do you not find from the report before you

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you that it was not so well understood?—I do not see how it could be otherwise.

2385. Do you mean to say that there was no fuse, and that it was easy to plug your shell up with the service fuse without any experiments?—The experiments were to try my principle for accuracy and range, as I understood, and it did not require the fuse put in the shell for that purpose.

2386. Would you fire your shells without a fuse?—Yes.

2387. Would you fire them loaded?—No.

2388. Unloaded?—Yes, for accuracy and range.

2389. What result would you expect from an unloaded shell without a fuse?—That would be merely for accuracy and range.

2390. Do you think you would get either in that way?—Yes, with my gun you would do so.

2391. Mr. *Vivian.*] Is there any reason why the Ordnance Select Committee should not have screwed the ordinary service fuses into them?—No reason whatever.

2392. Did you imagine that a Committee who were appointed to try a gun or a system of artillery, would have neglected to put the ordinary service fuses into the shell, if they were suitable for it?—No, I certainly did not.

2393. Colonel *Dunne.*] Was there any communication from the Committee to you, as to what shot or shell you wished to be used?—I cannot say that there was.

2394. *Chairman.*] Have you the correspondence with that Committee?—Yes.

2395. Could you put in that correspondence?—Yes.

2396. Colonel *Dunne.*] Was there any communication with the artillery officers of that Committee with regard to the shot or shell, they wishing to know what missile you proposed for your gun: was there any verbal or written communication with them?—I think not; I think there is no written communication.

2397. Was there any verbal communication?—I cannot call to mind at this time.

2398. But, clearly, you say there was no refusal on your part to give an opinion with respect to the shot that ought to be used?—No, certainly not.

2399. Nor was there any proposal on their part as to the kind of shot to be used?—No.

2400. Nor as to the mode of using the shot, or as to the fuse to be applied?—Nothing.

2401. Was it clearly understood, between you and them, that it was to be left to the decision of the Committee?—I did not know at the time that the experiments were going on.

2402. Mr. *Vivian.*] If the Committee had expressed a wish that you should have furnished them with a Shrapnel shell, or with a drawing of a Shrapnel shell, should you have had any difficulty in doing so?—No.

2403. But they never requested you to do so?—No.

2404. They have complained of your not having done a thing that you were never asked to do?—Yes.

2405. Major *O'Reilly.*] Sir William Wiseman states, "We could not test Mr. Whitworth's shell as a live shell, because there was no fuse for it." Did the Committee ever ask for a fuse for it?—No.

2406. Captain *Jervis.*] Did you ever ask the Committee to use the common fuse for your shell?—I did not know that the experiments were going on, and that is one of my complaints.

2407. Do you know what a Shrapnel shell is?—Yes.

2408. Do you think that it is a simple matter to make one from a drawing sent in by an inventor?—No doubt it is a very difficult matter to apply a good fuse to a Shrapnel shell. I have had no experience, and therefore I do not pretend to give an opinion upon that point.

2409. And do you not also know that it is a very difficult thing to make the Shrapnel shell itself for the different natures of guns?—No.

2410. Are you aware that it has been the greatest labour of artillerists for the last 50 years, including France, Russia, Austria, and that even yet they have not got a Shrapnell shell with which they are perfectly satisfied?—I can easily imagine that.

2411. But you think, nevertheless, that it is the duty of the Ordnance Select Committee, when inventors bring a gun before them, to work out a Shrapnel shell for that gun?—No; but I do not see what the trial of a Shrapnel shell has to do with the trial of the gun.

2412. Are you not aware that that is the most important part of our armaments at the present day?—Yes.

2413. And that the gun would be very useless to us unless we had a Shrapnel shell fitted to it?—I am aware that it is considered very desirable to have one.

2414. Do you not know that no system of artillery could be introduced for ourselves without one?—I hardly know how to answer that question.

2415. Do you think that it could be done?—I do not pretend to have any opinion upon that point; it is a question for an artillery officer.

2416. *Chairman.*] Were you present at the comparative trials of your guns with Sir William Armstrong's guns?—No, I was not.

2417. Captain *Jervis.*] Could you give the dates of the trials; I mean the trials before the Ordnance Select Committee?—I never had any notice of such comparative trials before the adoption of Sir William Armstrong's gun. No opportunity was ever given me of being present at the trials of my gun when the Committee decided against it.

2418. Sir *Morton Peto.*] When were you first aware of those alleged difficulties on the part of the Committee with regard to the projectiles as a reason for your gun not being tried?—Not until it was stated to this Committee in evidence.

2419. Captain *Jervis.*] Do you refer to the trials before Colonel Mitchell's committee?—Yes.

2420. Had you then a gun for trial?—Yes; it was a brass gun rifled.

2421. Your system of rifling was to be tried, but there was no gun made by yourself?—No; it was a brass gun rifled on my principle, the gun coming from the Government stores.

2422. *Chairman.*] Were you at that time a manufacturer of guns?—No.

2423. Can you give the Committee the date of the first complete gun that you sold?—Yes; I have a paper here, which I will put in, with regard to the dates at which we supplied guns.

2424. But will you give the date of the first gun that you sent out in such a complete form that you could sell it?—

2425. General *Peel.*] Was it subsequently to the report of that Committee?—Yes.

2426. Captain *Jervis.*] How long subsequently was it?—That Committee was in 1858.

2427. What was the nature of that gun?—It was a 70-pounder breech-loading gun.

2428. What was it constructed of?—It had a homogeneous tube and wrought-iron hoops. I was not informed until long after what were the results they had obtained, or on what grounds they objected to my gun; the only opportunity I have had of seeing comparative trials between our respective guns was recently at Shorncliffe and at Shoeburyness, when my shells were fired against metal plates.

2429. When we talk about the comparison of your gun and Sir William Armstrong's by that Committee, do you not think it should be remembered that Sir William Armstrong proposed a gun of his own construction, as well as a system of rifling of his own, while yours was a service brass gun, bored on your system of rifling?—Yes. But I should at the present time very much prefer the brass gun rifled, as I then rifled it, to the Armstrong service gun of to-day.

2430. But that is not my question; my question is whether it is quite a fair way of expression to talk about your gun when Sir William Armstrong originated his gun as well as the system of rifling, and yours being merely a system of rifling adapted to the brass gun existing in the service?—The first gun that we actually and entirely made was the solid homogeneous metal gun.

2431. We are talking about the guns that were brought before that Committee, at which time you had not constructed any gun?—No; we took a brass block, and bored it and rifled it; we had not a gun.

2432. *Chairman.*] The comparison, in fact, was between the two systems of rifling?—Yes.

2433. I think you state that there were trials made, on the 2d of April 1861, between the Armstrong 12-pounder gun and yours, at which you were not present?—Yes.

2434. Do you see anything in the results obtained there that you think requires explanation, or in any of the results that you have seen, from tabular statements that have been submitted to you, of your gun and the Armstrong gun?—Yes; the results recorded as obtained by the Ordnance Select Committee do not represent the ordinary shooting of the gun. I will take the column "Mean differences of range," and will read from the Report of the Institution of Civil Engineers for 1861. At five degrees my gun is made to show variations in range represented by 119 yards. This bad shooting was not the fault of the gun; for at double the elevation, and nearly twice the range, the mean differences were only 25 yards. In other words, the gun is made, according to this summary of the Ordnance Select Committee, to shoot five times closer at a range of 4,300 yards than it does at a range of 2,300 yards, which is absurd.

2435. Captain *Jervis.*] Is that the same gun that you have been speaking of?—It is not the brass gun, it is another gun.

2436. That table referring to a different gun, can you draw a comparison between the two?—This is a trial between the Armstrong 12-pounder breech-loading gun and my breech-loading gun, which took place at Shoeburyness.

2437. What size gun was yours?—A 12-pounder. They were both the same size.

2438. But was that a gun similarly constructed to the one that was before the Select Committee to which you have referred?—No.

2439. You are not drawing a comparison between that gun and the gun tried before the Ordnance Select Committee?—No.

2440. *Chairman.*] Suppose you had been present at the trial in question, could you have prevented that discrepancy in the result?—Yes. On looking at the Ordnance Select Committee's table of ranges, I find that at five degrees, five shots being fired, the average of four shots was 2,441 yards, but the other one was only 2,072 yards. Now, it is evident that there was something wrong in the shooting of this one shot, as it fell 369 yards short of the average of the others; but the Ordnance Select Committee included it, and a very bad average resulted. Had I been present, I should have protested against this; for it was clearly caused by some mistake, and the shot ought to have been fired again.

2441. Captain *Jervis.*] What does the term "average" express?—There were five shots fired, and the average shooting from the four shots was 2,441 yards.

2442. Supposing four shots had to be fired from a gun, surely if one shot were as good as another you would not try it over again, and then state your average?—No; this one shot fell 369 yards short, and there must have been some mistake in the charge.

2443. Nevertheless, the average gave the result of all the shots?—The average of the four shots was what I have stated; it was 369 yards more than this one particular shot.

2444. Mr. *Vivian.*] If you desired to arrive at the truth, and a portion of the data on which you are to arrive at the truth contained a manifest error, would you not discard that error, and endeavour, by repeating your experiments, to arrive at the truth?—Certainly.

2445. *Chairman.*] You stated that you only became a manufacturer of guns in 1859; but before that time, I believe, you had given a great deal of assistance to the Government, in order to enable them to discover what was the best system of rifling?—Yes.

2446. What led you to adopt the polygonal system of rifling?—When I first turned my attention to the construction of rifled guns in 1854, I saw there would be great difficulty in using cast-iron for rifled guns of large calibre; I thought the difficulty might be overcome by making the gun in segments of cast-iron, and hooping them with hoops of wrought-iron. The cast-iron segments would resist the wear of internal pressure and of the explosive gases, and wrought-iron hoops would resist the circumferential strain. The system of rifling that suggested itself to me, as being best applicable to this construction of guns, was the polygonal, as it afforded mechanical facilities for its employment. I adopted it; and the more experience I had of its use, the more its advantages developed themselves, both with regard to guns and projectiles; and I now feel quite sure that it is the best system that can be employed.

2447. What are the special advantages which you consider to belong to the polygonal form of rifling?—It enables projectiles of the most simple character to be used; they are the cheapest that can be made, as they are easily produced by self-acting machinery. The projectiles cause very little wear from friction, as they have a great

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extent of rifling surface. The necessary windage is provided for without the projectile becoming eccentric to the axis of the piece in coming out of the gun, which would injuriously affect the shooting. It is little liable to injury, and affords great facility for loading easily. Perhaps I ought to explain, that although the system of rifling adopted by me is termed the hexagonal system, the section of one of my rifled guns is not a real hexagonal. There were practical advantages in rounding the corners, and windage is provided for by easing off, as mechanicians say, the half of each side of the hexagon; also, in making the flat sides of the hexagon, part of the original bore is left in. These may appear slight modifications, but they are most important. The section which I now produce is still, apparently, hexagonal, but in reality there are 24 surfaces. The projectile has six flat sides and six rounded surfaces, making 12. The Committee will see that the shot which I produce is rounded off at the corners.

2448. Mr. *Vivian.*] To what size gun does the section and shot refer?—To a 5½-inch bore.

2449. Is that cut from the gun?—No; it is a model made for the purpose, which shows how the windage is obtained without the shot being eccentric to the bore.

2450. Captain *Jervis.*] Was that the original principle of rifling which you introduced before the Committee of 1858?—Yes.

2451. It was a mere 6-sided hexagon, then, was it not?—No, the only difference is, that the rounding off is now a little more, but the figure is precisely the same.

2452. You have rounded off a good deal since then, have you not?—It is a little more rounded off, not a good deal; but in other respects it is precisely the same now as it was in 1856.

2453. Sir *John Hay.*] You have improved it?—No, I cannot say that we have improved it. The windage is here just the same as it was in 1856. I should, at the present moment, rifle the brass gun precisely the same, and with the same rotation as I did in 1857.

2454. *Chairman.*] Are you acquainted with other systems of rifling?—I am; I consider much misapprehension exists with regard to the form of rifling, it being imagined by many that accurate shooting depends on the form of rifling given to the gun. This is not wholly the case. There are many forms of rifling which, if the gun is kept clean, will shoot well, if it be accurately made; and those who have a knowledge of accuracy of measurement and of true surfaces may make rifle guns shoot well with various forms of rifling. I much prefer the polygonal system, others the polygroove rifling, or the gun rifled on the French system, which fires projectiles with projections on them. As far as shooting alone is concerned, all these different systems may shoot well if the guns are properly made; but there are other practical considerations of great importance which have to be taken into account; above all, simplicity, durability, and economy must be considered.

2455. What are the peculiar features in the system of rifling adopted by you?—As I have stated, I used first the polygonal form of bore; second, a rapid rifling turn, giving much quicker rotations and greater length of projectile; third, reduced diameter of bore, by which I have less resistance of air. That applies to the small arm as well as the ordnance. This is the report of the Ordnance Select Committee on small arms; they say, "They are of opinion that as the makers of every small bore rifle, having any pretension to special accuracy, have copied to the letter the three main elements of success adopted by Mr. Whitworth, viz., diameter of bore, degree of spiral, and large proportion of rifling surface, it is not probable that any further modifications or *quasi* improvements, that might result from the question being now thrown open to the gun trade, would be attended with any practical advantage."

2456. What are the points which, in your opinion, ought to be considered in producing the most effective gun?—In dealing with the question of gunnery, it is necessary to consider, first, what is the best material for the gun; secondly, the weight and length of gun that are admissible; thirdly, its construction; fourthly, the system of rifling and the amount of rotation; fifthly, the windage to give easy loading, and provide for the ignition of the shell; sixthly, the proper material for the projectile, considered in relation to what it has to do; seventhly, the length of the projectile, both shot and shell; and, eighthly, the form of projectile with reference to range, penetration, and destructive effect.

2457. Would the shot issue as quickly from your gun as from a smooth-bored gun?—Yes; but that would depend on the length of the shot. I have here the two extremes. This is a spherical shot, which is also rifled, and it will go out quicker than if it were not rifled (*referring to a model*). The other extreme is shown by this model, which represents a shell 10 diameters long, which we fired a great deal in 1856, when I wanted to get the proper rotation and proper length of projectile; it certainly did not go very quickly out of the gun as compared with the spherical shot.

2458. Sir *John Hay.*] Will you explain to the Committee why a spherical shot rifled, of the same weight as another shot not rifled, and with the same charge of powder, should go quicker from a rifled gun than a shot not rifled?—We have found, in experiments with the 12-pounder gun, that we get, with a rifled sphere, 2,200 feet initial velocity; and therefore it must be going quicker out of the gun. I have never heard of a velocity equal to that from a smooth-bored gun not rifled.

2459. But has a sphere of the same weight, the same diameter, and the same charge of powder, been fired by way of comparison as against that?—The charge of powder from the smooth-bored guns has been equal to the charge of powder in this case. The old service charge, I believe, was three times the weight of the shot to that of the powder. I have in these initial velocity experiments an instance of a projectile not spherical, but 1½ times the length, and the proportion of powder is 3 to 1. The velocity being 1,900 feet for a 12-pounder. I believe the velocity of the 68-pounder smooth bore is 1,600 feet.

2460. Mr. *Vivian.*] Then your rifled spherical shot from a 12-pounder gun gave 2,200 feet against 1,900 feet initial velocity?—Yes.

2461. To what do you attribute that increase of velocity in the rifled sphere?—The whole force of the powder is more utilised in the rifle than in the smooth bore.

2462. There is less loss of gas by windage?—No doubt; at all events we have to deal with facts, and the facts are what I have stated.

2463. *Chairman.*] Is not your system of rifling applicable

applicable to breech-loading guns?—It is as applicable to breech-loading as to muzzle-loading guns. My breech-loaders can, if required, be used as muzzle-loaders. In case of any accident happening to the breech-loading arrangement, the gun would be loaded at the muzzle.

2464. Are you a partizan of the breech-loading gun?—I am not. The muzzle-loading gun being so much more simple and equally as rapid for loading. In the trial of the brass rifled gun against the same gun as a smooth bore, there was no advantage at all which the smooth-bored gun had over the rifled gun, each was loaded and fired as quickly as the other.

2465. Do you mean that the breech-loader cannot be fired more rapidly than the muzzle-loader?—Yes. The muzzle-loader rifled on this system is fired as rapidly as any breech-loader that I ever knew.

2466. Do you not find that your guns wear considerably from the use of hard metal projectiles?—The wear in my guns is comparatively very small. There is wear in all guns, arising from the effects of the explosion of the powder, but owing to the great extent of the surfaces of the projectiles in contact with the bore of the gun, the wear due to friction is reduced in my guns to a minimum.

2467. What guns did you rifle for the Government before 1859?—Three 24-pounder brass howitzers, one on 8th July 1856, one on 30th November 1856, and the one which is now in Manchester, which was also rifled, on 30th November 1856. One 12-pounder brass gun, 26th July 1856, one 9-pounder brass gun 19th November 1856, one 6-pounder brass gun 5th December 1856, two 32-pounder cast-iron blocks, one 9th February 1858, and one 7th September 1858, and one 68-pounder cast-iron block 21st August 1858.

2468. Was that all?—Yes.

2469. Was it after the cast-iron guns supplied to you to be rifled, were found to be too weak in 1858, that you received an intimation from the Government that no more guns were to be rifled on the Whitworth principle?—Yes.

2470. But was there any reason given?—No. In consequence of the cast-iron guns having burst, there were to be no more guns rifled on my principle.

2471. When were those cast-iron guns tried?—The 32-pounder was tried at Shoeburyness, and the 68-pounder at Portsmouth. The latter gun, on the first day it was tried, fired its projectile completely through the four-inch armour plate and timber side of the "Alfred," at 450 yards. That was in October 1858.

2472. Is there a report of that?—I have no doubt there is.

2473. Captain *Jervis.*] How many rounds were fired?—Two or three rounds.

2474. When did it burst?—It burst, I think, the next shot that was fired; after it pierced the armour plate.

2475. That was the first shot, and the second shot burst?—Probably.

2476. Sir *Morton Peto.*] Those were cast-iron guns?—Yes.

2477. Were they rifled on the polygonal principle?—Yes.

2778. Does not that system take a much larger amount of metal out of the surface of the gun?—It takes more than the polygroove system.

2479. And therefore it must weaken the gun?—You must leave the gun so much the stronger if you rifle on that principle.

2480. In the 68-pounder you would practically have a weaker gun after rifling it on that system, than if the other system of rifling were adopted?—The 68-pounder smooth bore is eight inches in diameter, but the outer diameter of the hexagon would be 5 ½ inches, so that there was an extra strength of metal left.

2841. Mr. *Vivian.*] Have any cast-iron rifled guns been successful in this country within your knowledge?—There has been a certain amount of success with very short projectiles and low charges.

2482. But not with the same projectiles and charges that were used with your polygonal rifled guns that you just now spoke of?—No.

2483. Did not Mr. Bashley Britten have a good deal of success?—Yes.

2484. Was that with low charges?—Yes, with low charges and short shot.

2485. Were any of the brass guns rifled by you before 1859 adapted for the naval service?—They were. I had rifled some brass 24-pounder howitzers, which fired projectiles of 12, 24, 32, and 48 lbs. weight. In 1856 I fired from them experimentally shells 10 calibres long and capable of holding a large charge of powder. The quick turn enabled any requisite length of projectile to be fired, and that gave increased capacity for the bursting charge without increasing the size of the bore. Flat-fronted shot fired from one of these guns on board the "Excellent" proved that the projectiles would pass through water, and penetrate a ship's bottom several feet below the water-line.

2486. How many feet below the water-line?—The experiment that we had at Portsmouth was with a 24-pounder howitzer, the shot weighing 32 lbs. and the powder 2 ½ lbs. The shot went through 30 feet of water, going through eight inches of oak three feet below the surface.

2487. Did you in the first instance try to employ for your built-up guns welded coiled hoops?—I did not for the inner tube of my guns, but I did for the outer hoops, as has already been explained to the Committee. I thought it better to employ for the inner tube a harder and much tougher metal, and to dispense with welded joints. I therefore gave great attention to the improvement of what is now termed homogeneous metal, and I now use it with great confidence.

2488. Were there any official trials of your guns at Southport?—There were some trials made in the presence of naval and artillery officers. My first Southport experiments attracted a great deal of attention; and the Government sent down officers, including the President of the Ordnance Select Committee, to witness further trials at Southport of my breech-loading guns, including 12-pounders and the 70-pounders. A report was made on those trials, but no copy of it was ever given to me; that is the report that we have previously spoken of.

2489. What guns of yours were fired against the plated targets at Shoeburyness?—The 12-pounder breech-loading gun weighing 9 ½ cwt. The 5 ½ inch built-up gun, weighing 3 ¾ tons, and the 7-inch built-up gun weighing 7 ½ tons. The 12-pounder sent a shot through a 2 ½-inch iron plate placed at an angle of 45 degrees at 200 yards. The 5 ½-inch gun sent shell through 4 ½-inch iron plates, 18 inches of oak and ⅜-inch plate, backing at 600 yards. The 7-inch gun

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sent shot and shell through the improved Warrior target, consisting of 5 ½-inch plates, 18 inches of oak, ⅜ plate, backing at 800 yards.

2490. Are you now making large guns at your works in Manchester?—We have been manufacturing them hitherto in the Manchester Ordnance Company's works of the calibre of 5 ½ inches, and we are now making larger guns, the 7-inch and 9-inch.

2491. Were those made altogether of homogeneous metal?—Entirely.

2492. Which metal you obtain in this country?—Yes.

2493. Have you any objection to state at what price you are able to make those guns?—The 1-pounder rifle gun costs 35 *l.*

2494. Is that the same class of gun as you sent out to China?—Yes; the 6-pounder costs 75 *l.*, the 12-pounder 120 *l.*, and the 5 ½-inch 700 *l.*

2495. Mr. *Vivian.*] What is the price of the 7-inch gun?—We have not yet definitively determined the price of that.

2496. You have made some, and sold them, have you not?—We are making them.

2497. You have made them, have you not?—No; they are in hand. The 1-pounder rifled shot cost 1 ½ *d.* each, the 6-pounder 9 *d.* each, and the 12-pounder 18 *d.* each. This is a casting of the 12-pounder shot just as it is cast, without anything being done to it (*producing a sample*).

2498. Is that open sand casting?—Yes, open sand casting.

2499. That is the cheapest description of casting known, is it not?—Yes; the shot are not used in this state; they are shaped in a machine, and that is the price of the shot shaped.

2500. *Chairman.*] Is it necessary for your projectiles to be made to fit the gun with great accuracy?—No, it is not at all necessary that the mechanical fit between the projectile and bore should be exact; but it is very desirable that the projectiles should be alike, and this is done by the aid of the self-acting machinery we employ.

2501. Are all your ordinary projectiles shaped by a machine?—They are all shaped by a machine, and their cost is very trifling,

2502. Can you fire your projectiles as they are cast?—We can do so, but the expense of shaping by machinery is very small, and the shooting is more accurate, so it is not worth while considering it. I may mention that in shaping this shot we can do it at a cost of 6 *d.* per dozen for labour with self-acting machinery.

2503. Can you afford any means of comparison between the cost of the compound lead-coated projectile, and the simple cast-iron one; take an ordinary size, for instance?—The gun that is most employed, and fires the greatest number of shot, will, perhaps, be the best, that is the 12-pounder. I find that the prices paid to the Elswick Ordnance Company for 12-pounder solid shot have ranged from 6 *s.* 3 *d.* to 3 *s.* 4 *d.* each, as will be found on reference to page 171 of the Ordnance Blue Book of last year. The price of my 12-pounder solid shot is 1 *s.* 6 *d.*

2504. General *Peel.*] None of those guns or ammunition were in existence when the Armstrong guns were adopted into the service, were they?—Yes.

2505. I thought you said that you had made no gun till the latter end of 1859?—Yes.

2506. That was subsequently to the Report of Select Committee?—Yes, but the same shot was fired.

2507. Mr. *Vivian.*] But rifled brass guns in considerable number were in existence prior to the Report of the Select Committee, were they not?—Yes.

2508. You had rifled brass guns as far back as 1856, I think?—Yes.

2509. Which were precisely the same, and capable of throwing the same shot as you now produce before this Committee?—Yes; we had not at that time this exact form of shot, with the taper rear; but with that exception it was the same then as it is now.

3510. In reference to comparing the cost of lead-coated shot and the cost of mechanically fitting shot, the mechanically fitting shot had the same existence in 1856 that the lead-coated shot had?—Exactly.

2511. General *Peel.*] But what was the ammunition that was tried with your gun before the Select Committee having been furnished by you?—Solid shot and hollow shell.

2512. You appear to have been under an impression that some unfair advantage was given by the Ordnance Select Committee to Sir William Armstrong in comparison with yourself, for in your letter which you addressed to the "Times" in November last year, you used the following expressions, "Why has not Sir William availed himself of this mode of comparison, which was open to us both, had he so desired it? In his letter he expresses an opinion that it is high time that a proper and systematic comparison should be made between Mr. Whitworth's guns and his. He therefore admits that no such comparison has yet been made, though the Rifle Ordnance Committee, in 1858, decided in favour of his gun, and against mine. In a former communication I alluded in general terms to this subject, but from comments made on my letter in your leading article, it appears that my allusions did not convey sufficient information. It is therefore necessary plainly to state what were the proceedings of the Rifle Ordnance Committee, with reference to the Armstrong gun and mine, when they recommended the former to be adopted for the service. I am now for the first time enabled to give this explanation, having just received the recently published report of the evidence given before the Select Committee of the House of Commons of last Session. Its Appendix furnishes me, for the first time, with a copy of the Ordnance Committee's report upon the Armstrong gun and mine, and with a list of the Members by whom it was made. Among the most prominent of those Members were, Sir W. Wiseman, now the Vice-president of the Ordnance Select Committee, and the secretary, Captain A. Noble, who afterwards became a partner in the Elswick Ordnance Company. From the evidence by the House of Commons it appears that a programme of the trials of the Armstrong gun proposed to be made in 1858 was previously submitted to Sir William by the Committee, and he consented to it, stipulating, however, 'that he should be allowed to co-operate personally or by his assistants.'" Will you have the kindness to show me in the report of that Committee the passage you referred to in that letter to the "Times"?—On page 166 of the Appendix to the Blue Book of this Committee I find Sir William Armstrong saying, "I quite concur in the above suggestion, provided I be allowed to co-operate in the experiments, either personally or by assistants, whenever I may see occasion."

2513. Was that what you alluded to in your letter to "The Times"?—Yes.

2514. Then will you be so kind as to look at the date of that?—It is dated 24th February 1858.

2515. Are you not aware that the submission to Sir William Armstrong, and that answer of his, were made by the old Ordnance Select Committee, which was before I was in office?—I am aware that that Committee existed before you were in office.

2516. Are you not aware that Sir William Wiseman was not a Member of that Committee?—Was he not Member of both?

2517. No. You seem to have imagined, did you not, that the submission which was made by Sir William Mitchell was made by the Committee which was appointed by me to decide on the best gun to be adopted in Her Majesty's service?—I am not aware of the difference in the constitution of the two Committees, but I believe there is no doubt that Sir William Armstrong was present at the trials, and it is certain that I was not.

2518. I am referring to your letter, in which you seem to have confounded the two Committees?—Then there I made a mistake.

2519. Sir William Wiseman was not a member of the Committee which made that submission, was he?—No.

2520. Having had your attention called to that, do you now admit that you made a mistake in the letter to "The Times," from which I have read you an extract?—I see that a distinction is to be drawn between the two Committees. There was one Committee at the beginning of the year, and another Committee at the latter end of the year.

2521. Of the first of which two Committees, Sir William Wiseman was not a Member?—Yes.

2522. There your observations could not apply to him, could they?—The same paper goes on farther, and is signed by Colonel Mitchell, Captain Wiseman, Lieutenant Colonel Smythe, T. M. Wemyss, and Captain Hay.

2523. But I think you will see that that is quite a different paper, being marked E, while the previous paper is marked B?—Yes; I now see that.

2524-5. Mr. *Vivian.*] Let me ask you, in order to put you right in this matter, whether it is not the fact that in the report as printed there is no distinction drawn between the two Committees; the report of one Committee following the submission of the other without any break to lead you to suppose that there was a difference?—Just so.

2426. You were misled by the manner of the printing, were you not?—I was not aware that there were two separate Committees; but my great ground of complaint remains, I presume, the same. What I complained of was that I had not an opportunity of being present at the trials between my guns and Sir William Armstrong's.

2527. General *Peel.*] Your ground of complaint was that you imagined the Committee which decided between the two guns, your's and Sir William Armstrong's was the same Committee as that which submitted the programme marked D, printed at pages 155 and 156 of the appendix to the last year's report of this Committee?—I now see that I was wrong in that.

2528. I see you stated in your evidence the other day, that to certain experiments which had been sanctioned by the Government, a stop was put by a letter from me?—Yes.

2529. In the month of August 1858, a certain sum of money was paid to you by the War Department, being 4,000 *l.* odd, was it not?—Yes.

2530. Are you not aware that the reason why I stopped those experiments was, that there was no money taken in the Estimates even for the payment of those 4,000 *l.*?—I think the letter of General Peel states, that it was in consequence of two cast iron guns having burst, and that therefore, there would be no more experiments made with guns rifled on my principle; I have the letter here, and will beg to read it to the Committee:—"War Office, 20th December 1858. —Sir,—With reference to your letter of the 18th October last, I am directed by Secretary Major General Peel to inform you, that the special Committee on rifled cannon have reported that they are unable to agree with the opinion expressed by you as to the cause of the bursting of the gun in question, as it constantly happens with all natures of Ordnance; that the chamber is not filled with powder, and air spaces of much more than 62 cubic inches frequently occur without danger. I am at the same time to state that, as all three of the cast iron polygonally-bored guns which have been submitted for trial have burst at a very early stage of the experiments to which they have been subjected, Major General Peel has determined to discontinue further experiments with Ordnance rifled on this principle."

2531. That letter has not reference to the question of expenditure to which you allude in your evidence, has it?—No; there is nothing in it about expenditure.

2532. I understood from your evidence, that you stated I had put a stop to experiments going on, which had been sanctioned by the previous Government?—The reason given here is because a gun rifled on my principle had burst, implying that my particular system had caused the bursting of the guns, whereas the guns in question were service guns, and burst because they were too weak. But all the guns that we had previously bored and rifled, namely, brass guns, had been very successful.

2533. But with respect to the service guns, there had been no expenditure had there, except as to the mere rifling of them?—The boring and rifling, and making the necessary tools.

2534. Did that form any portion of the 4,000 *l.* paid to you by the War Department for which no money was taken in the Estimates?—It must have been; no doubt it did.

2535. Therefore, no money having been taken for it in the Estimates, was it not very probable that all experiments would be put an end to till the Secretary of State had an opportunity of coming to Parliament for the money?—From the letter I have read I understood that I was not to continue my experiments, because of the bursting of the guns rifled on my principle, they being cast-iron guns.

2536. Each of which burst after one or two discharges, did it not?—They did what I think was a most important service at that period, namely, showing that you could send a shot through an iron plate at a distance of 450 yards, and I think it is a great pity that that result was not followed up.

2537. But I presume you would hardly recommend the adoption into the service of a gun that would only stand one or two discharges?—No;

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but I think that cast-iron was an improper material. The brass guns were very successful.

2538. But when the Committee decided between your gun and the other rifled guns that were before it, that was the only gun of yours, was it not, which was before the Cummittee?—There were several brass guns.

2539. Was it a brass gun of yours that was tried?—Yes.

2540. Therefore, the decision of that Committee had no reference whatever to the material out of which the gun was made, but it was the system of rifling upon which they decided?—Yes

2541. You had no other gun of your own then; had you your first gun; the gun that you had at that time was a service brass gun rifled according to your system, was it not?—Yes.

2542. And as to all the guns that you had subsequently made so remarkably well, that Committee had no opportunity of judging of their merits?—No; but I think that the brass gun that we had then is a superior gun to the present wrought-iron gun.

2543. That of course is a matter of opinion between you and the Ordnance Select Committtee?—Yes.

2544. But as far as the Government were concerned, the only gun of yours which they had before them to judge from at that time was that brass rifled gun?—Yes.

2545. Sir *John Hay*.] You have stated that in 1854 the system of hexagonal rifling suggested itself to you; I thought you would like to correct that, because you would hardly say that it suggested itself to you, if you accepted it from Mr. Brunel?—No.

2546. Then was that entirely your own invention?—I was led to it, as I have explained, by this segmental gun.

2547. You had no sort of assistance from either Mr. Brunel or Mr. Westley Richards?—After we had the rifle gallery erected, experiments were made which Mr. Westley Richards attended, and he brought the polygonal rifled gun that he had made for Mr. Brunel, and it was fired in the gallery; but my attention was drawn to the subject before.

2548. Then, from independent sources of information, or from independent reasoning altogether, you both adopted the same system, being simply concurrent?—I suppose so. I believe that polygonal guns had been thought of by, perhaps, many persons previously. I remember seeing them in the museum in France, but the thing had never been practically worked out. There is a very great difficulty in working out a system of this kind; and it is only recently, by the aid of self-acting machinery, that such a thing has been practicable.

2549. But had you not a considerable amount of information from Mr. Westley Richards before you made that gun?—None whatever with reference to that gun. All that he did was to show me the rifled gun that he had made for Mr. Brunel, which was octagonal, with an increasing pitch; and Mr. Westley Richards told me that the second gun which he made was quite a failure. He did all in his power to try to persuade me to abandon the thing, but I saw its value, in consequenee of being able to apply self-acting machinery for producing projectiles.

2550. You do not acknowledge any obligation, either to Mr. Brunel or to Mr. Westley Richards, then?—I do not say that. I am very much indebted indeed to Mr. Westley Richards for all the information that he gave me with respect to the manufacture of rifles generally, for he had been associated with a previous Committee for the production of the best rifle.

2551. But you owe nothing to Mr. Brunel?—Nothing whatever.

2552. Captain *Jervis*.] Is it the fact that the success of your rifle, with a close fitting bullet, was so great, that about 1856 the Government asked you to rifle certain brass guns in the same way?—Yes.

2553. And that the results were so far satisfactory, that the Government asked you whether you could rifle certain cast-iron guns?—Yes.

2554. And up to that time, although there was a certain success, you had not brought your shot and shell to such perfection as you would have desired yourself?—Are you speaking now with regard to the beginning?

2555. You are aware that as you go from one size to another, there are a great number of questions to be considered with respect to adapting shot and shell to guns; you were not satisfied yourself with the shot and shell you had about the year 1858, I think?—The shot which I had in 1858 was precisely the same, with the exception of the outward form, as it is now.

2556. That is very important when you come to the question of the flight of the shot or shell, is it not?—I think it of great importance, but others may not think it of great importance, as it has not been adopted in the service.

2557. But your shot and shell at that time were not identically the same, and gave very different results from what they do now, did they not?—No, I am not aware that they did.

2558. You are acquainted with the report of the Committee on the 16th November 1858, in which they say, "That the projectiles have a large and rapidly increasing deflection to the right, the allowance for which is so considerable as to render it a matter of difficulty to give the necessary connexion when aiming at varying distances"?—Yes; "The results practically show that it is a matter of great difficulty to give the necessary corrections when aiming at varying distances," That is one of the objections raised to my gun and projectile at that time, and I can only express my surprise at such an objection being made, because we find that it depends entirely on the direction of the wind; they will go to the left or to the right just according to the wind, and, therefore, I maintain that that is no objection at all.

2559. You were so satisfied yourself that there were improvements to be made in the shot, that you devoted a good deal of time and attention to the outward form?—Not so much with regard to the accuracy of the shooting, as to the getting of longer flights.

2560. And getting greater accuracy?—I will not say so much with regard to the accuracy.

2561. You having devoted your attention to see whether you could not get a better metal for guns than cast iron, is it the fact that in March 1859, you proposed to the War Office to try experiments with homogeneous iron?—I daresay that I did so.

2562. You then tried boring out the solid?—Yes.

2563. You tried experiments which showed that you could not always rely upon homogenous

geneous iron at that time, and you then introduced the inner tube bound with wrought iron?—I have never made a gun with an inner tube of wrought iron.

2564. On the 15th May 1861, you write from Fenton's Hotel, "I beg to acknowledge the receipt of your letter of 13th May. It appears to me that some misapprehension exists as to the nature of the request made by my firm; I am desirous of trying my principle of rifling with large guns made on the coil system; this has not yet been done; the Whitworth guns lately tried at Woolwich were all made with inner tubes of homogeneous iron." Referring you to your own letter, is it not the fact that finding you could not get sufficient masses of homogeneous iron on which you could rely, you tried homogeneous iron tubes bound together by hoops?—Yes.

2565. Those did not appear to have been so far successful, but that you asked to have guns made on the coil principle furnished to you?—We had had very great success with homogeneous iron for the rifle and for small guns; the first gun that I made to which we got a proper form of shot was the three-pounder gun; that was fired about 5,000 rounds and it is a very good gun now, so that we had every reason to be satisfied with homogeneous iron for rifled and small guns; but when it came to very large sizes we had not the means at Sheffield at that time to manipulate the iron properly, nor was there the means of annealing it properly; therefore, we had not that success with homogeneous metal for large sizes in consequence of not having proper machinery. The metal itself was almost as good as we could desire.

2566. But you feared at that time that you could not at that time rely upon getting the masses you required, and you therefore, used homogeneous tubes bound together with hoops of coiled iron?—Yes.

2567. Since then, you made application to Woolwich and got the tubes made of coiled iron which were to be hooped?—No, we made an application, but we did not get any.

2568. You never got them?—No.

2569. In the year 1859 you proposed homogeneous iron, did you not?—Yes.

2570. But in 1861, you did not seem satisfied with homogeneous iron, and you asked "to apply two coiled tubes inner, without which the application of my system of rifling to the coiled gun cannot be fairly tested;" you were then anxious that your system of rifling should be tested with the coil principle, because you were not satisfied with the homogeneous metal which you obtained at that time?—No, for the reasons I have mentioned.

2571. You furnished a battery to Shorncliffe, rifled on your principle?—Yes.

2572. Are you aware that they are reported as having very considerably failed. Have you seen the report that has been sent in to this Committee?—No.

2573. Would it not appear that the strain through the rifling of that brass gun was very much the cause of the failure?—I am aware of the state of those guns, because I have got gutta percha impressions made of the bore, and I can only say that I am very much surprised they are not in a far worse state. I myself saw 100 rounds fired from each of those four guns without one particle of lubrication, and without one drop of water being used for the 100 rounds. Such a thing was never known or dreamt that surfaces sliding one upon the other should be used without lubrication.

2574. But still I suppose they were fired in that way to see what they would do on actual service. They were not put to a greater test than any other gun in the service, were they?—I apprehend that on service you would never think of firing rifled projectiles with large surfaces without lubrication. It would be a great deal worse than a gentleman going out in his carriage without any oil on his wheels.

2575. Have you ever been in that predicament?—No, I have not; and I hope I never shall, but the fact is established, that 100 rounds were fired from those guns without a single mishap.

2576. In what year did you manufacture those guns that are at Shorncliffe?—In the beginning of 1862.

2577. Were all those guns, with the ammunition of those guns, similar to the brass gun, and the ammunition of the brass gun which you had tried before the Select Committee of 1858?—I think they would be the same with the exception which I have mentioned, namely, that the form of the projectile was different.

2578. That making a very considerable difference in the shot, or in the gun?—As I have explained, this shot, which I have here, is the most favourable form for a long flight.

2579. But that is not the form of shot you had before the Committee of 1858, is it?—No; it is the same in the rifling turn, and the same in every respect except just the outward form.

2580. Mr. *Vivian.*] The same, except with respect to the existence of the taper rear?—Yes.

2581. Captain *Jervis.*] But does not that make a very considerable difference with respect to accuracy, and its range?—I do not think it makes much difference as to accuracy, but as to range it does; for you will find, that at 10 degrees, my shot goes several hundred yards further than the service gun, and a great deal of that result is attributable to this form.

2582. Now, as the cast-iron gun of 1858 did not succeed, and the homogeneous metal gun of 1859 did not succeed, have we anything before us to show the correctness of your principle beyond the 70-pounder which was made on the coil principle, and was tried at Shoeburyness?—Yes; there is a 12-pounder.

2583. But I am speaking of large guns?—That was the only one which we had made.

2584. And that gun likewise for the same cause burst after a very few rounds, did it not. I mean the last gun made with wrought-iron?—The 80-pounder did not burst; the tube inside was cracked.

2585. But still that gun is considered unserviceable; is it not?—Yes.

2586. Do you know how many rounds it has fired?—No, but a good number.

2587. Was it 30?—More that that, I think.

2588. We have it in evidence before us that it was not 30, but that it might have been 20?—We fired it at Southport more than that, before it was sent to Woolwich.

2589. How many times did you fire it at Southport?—I do not remember.

2590. I am now referring to the gun that went straight from Woolwich to Shorncliffe?—I have been speaking of the 5½-inch gun.

2591. My questions have referred to the 7-inch

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gun that did not stand 30 rounds?—Does the Honourable Member mean the gun that was made at Woolwich?

2592. Yes; I ask you this, as the cast-iron gun burst so readily, and as the homogeneous iron gun burst, and as the wrought-iron gun made on your principle is also unserviceable, have we anything before us except the gun I have mentioned, by which we can judge of the correctness of your principle?—My reply would be, that the homogeneous gun did not burst.

2593. But you were not satisfied with it from 1859 to 1861?—I was always satisfied with the strength of the homogeneous iron.

2594. But in 1861 you write that you prefer the other, in order that your system of rifling may have a full trial?—I wrote desiring a 7-inch gun to be made for me.

2595. In your letter of May 1861, you say, "I am desirous of trying my principle of rifling with large guns made on the coil system; this has not yet been done; the Whitworth guns lately tried at Woolwich were all made with inner tubes of homogeneous iron. I was supplied from Woolwich with outer hoops of coiled iron for two guns, to these I wish to apply two coiled tubes inner, without which the application of my system of rifling to the coiled guns cannot be fairly tested." You wrote that in 1861; did you not?—Yes.

2596. Sir *Morton Peto.*] We have heard a great deal about the coil principle being something new, but is it not the fact that for a great many years we have been in the habit of seeing hydraulic presses built up in this way?—Yes.

2597. Marquis of *Hartington.*] You said that you thought the shot went as fast out of your gun as out of a smooth-bore gun; do you employ the same sort of powder as used to be employed with smooth-bore guns?—My reply was made upon the supposition that the same powder was used for both.

2598. But do you, in fact, employ the same powder as was used in the smooth-bore guns, or the same powder as that used by Sir William Armstrong?—We have always used the same powder as happened to be in use at the time in the service; we have had no special powder.

2599. No special powder is necessary for your guns?—No.

2600. Is not the recoil very great in your gun?—No, it is less.

2601. Then you use the same powder, do you?—Yes.

2602. Mr. *Vivian.*] With respect to the original invention of the polygonal system of rifling, I understand you to say that your original segmental gun could not have been carried out without the polygonal system?—No; the polygonal system seemed so naturally adapted to it, that I adopted it.

2603. The polygonal system was involved, was it not, in the segmental gun?—Yes.

2604. And you originally designed them, and applied for a patent for both together?—Yes.

2605. And that small model in mahogany was made when you applied for that patent?—Yes.

2606. Without at all detracting from the merit of Mr. Brunel, you appear at nearly the same time to have adopted the same idea?—Yes.

2607. Without any communication passing between you and him?—Precisely.

2608. You do not at all desire to detract from Mr. Brunel's merits with respect to the polygonal system of rifling; but you desire to assert that you at the same time adopted the same idea without concert?—Yes; and I am very much pleased to think that it did occur to Mr. Brunel also.

2609. Sir *John Hay.*] No communications passed between you, did they?—None, whatever; it appears Mr. Brunel was before me, and I am very pleased to think so.

2610. Mr. *Vivian.*] But you were not at all aware that he was before you?—Not at all aware of it.

2611. Now, with respect to brass guns; do you imagine that it would be worth while to carry on experiments upon brass ordnance at the present moment?—I do.

2612. Are they applicable to the system of rifling which Sir William Armstrong adopted, namely, the polygroove system?—they are not adapted for the polygroove system for muzzle loaders.

2613. But you are of opinion that it would be desirable to ascertain whether large and small artillery might not economically be made with brass, as was done in former days?—I should say so, and particularly for naval boat guns; the bronze metal is not subject to rust, and when the gun is worn out, it retains its value, and can be re-melted; I consider therefore it has many advantages; and I think it would be very important for us to have a good proof trial of the brass gun, and what its power of endurance would be when fired with proper lubrications.

2614. Is there any serious difference between the first cost of the metal of a brass gun and the material of an Armstrong or Whitworth gun?—The homogeneous metal is expensive; it is about the price of the brass gun; nearly so. The metal for the Armstrong gun is a very cheap metal, in comparison with the labour, I mean.

2615. So that by the time the gun is made, so much money in wages and other things has been expended upon the manufacture of the material, that it becomes almost as costly as the brass gun?—Yes.

2616. Do you approve of the system of manufacture which is at present adopted by the Government at Woolwich?—I do not.

2617. Will you state your objections to that system?—I have before stated that I believe wrought-iron, that is to say welded metal, is the very worst material you can use for a gun.

Lunæ 11° *die Maii*, 1863.

MEMBERS PRESENT:

Mr. Baring.	Captain Jervis.
Mr. Beecroft.	Mr. Laird.
Mr. Dodson.	Mr. Monsell.
Colonel Dunne.	Major O'Reilly.
Marquis of Hartington.	General Peel.
Sir John Hay.	Mr. Vivian.

The RIGHT HON. WILLIAM MONSELL, IN THE CHAIR.

Major General ALEXANDER THOMAS TULLOH, called in; and further Examined.

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2618. *Chairman.*] WHEN did you cease to be Inspector of Artillery?—On the 8th July 1861.

2619. I believe it is the fact, that almost all the 12-pounder Armstrong guns were received somewhere in 1859 or 1860?—The whole of them were received up to 1861. The number of 12-pounder guns that I examined during the time that I was Inspector of Artillery was 169.

2620. Can you tell the Committee whether those guns that were referred to in the report of the Committee of 17th November 1862 were among those guns that you inspected?—I inspected some, but none of those I passed have, I believe, failed.

2621. Can you inform the Committee what proof and inspection those guns did undergo?—They underwent the usual proof which every gun has to undergo, when received into the service, according to the proof laid down by the Ordnance Select Committee.

2622. But those guns were inspected by the Inspector of Artillery, were they not?—Not all of them. Two lined guns were passed by me; the last gun that I inspected was 169.

2623. Can you state what number of guns had been passed into the service under the first system of inspection that obtained?—119.

2624. When the final proof was discontinued, did the Inspector of Artillery continue to select guns for the service?—Yes, he selected them, as his particular duty.

2625. I think you stated, with regard to the selection, that "if the Inspector of Artillery has to select the gun and be responsible, the guns should be unpacked, and their previous history made known to him?"—Yes; that is to identify the guns and make a record, such as you could give to the officer commanding the battery to which those guns were to be taken.

2626. What is your opinion as to the amount of responsibility involved in the selection?—None whatever, as far as the construction of the gun was concerned. I speak now of the time after Lord Herbert's order.

2627. Taking the case, for instance, of a lined gun; do you think that it would have been the duty of the Inspector to select and issue for service a lined gun?—In the early stages of the manufacture, when a gun was delivered to the Inspector, it was very difficult for him to find out whether it was lined or not. The Armstrong gun is very different from other guns; for instance, from cast-iron guns. When a cast-iron gun is proved, and it bursts, another one is supplied, but an Armstrong gun is capable of being repaired, and placed in a state fit for proof again. If it passed into the service (I mean previously to Lord Herbert's order), the Inspector of Artillery would have selected it, and have been responsible.

2628. I think that two out of the four guns that were selected for Portsmouth, were lined guns?—Very possibly.

2629. The reason, I presume, that the Inspector of Artillery sent those guns down to Portsmouth was, that he did not know whether they were lined or not?—Not at all; he had nothing to do but to select the guns The responsibility rested with the Superintendent of the Royal Gun Factory. The way in which guns are brought into the service is by the broad arrow being placed upon them, and when that is done, if they are contract guns, they are paid for; and no after-proof, or anything else, can make any alteration.

2630. But still the Inspector of Artillery, who had to select the guns, was right in requiring that the guns should be unpacked, and their previous history made known to him; that is your own statement?—Yes; that is in order to make the record I have spoken of, but not to be responsible for the gun.

2631. Captain *Jervis.*] Was the broad arrow on the guns which were delivered from the Royal Gun Factory when you received them?—Yes; without that the storekeeper would not take them; that is the proof that they have been proved and are fit for the service.

2632. *Chairman.*] But when you inspected the guns the broad arrow was not put upon them until you had inspected them; was it?—No.

2633. But before you inspected them, was the broad arrow put upon them?—No, they went through the proof under my orders; the other guns did not.

2634. Was Captain Dyer the officer who selected those guns?—Perhaps he had better answer for himself; I cannot say.

2635. Was it Colonel Strange?—I think it was.

2636. Can you say whether it was considered to be the duty of the Inspector of Artillery to receive

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receive and to select any guns that were lined?—There is no question about that; he is not responsible for it; he could not be so; the broad arrow is on the gun, and it is supposed to be fit for the service.

2637. Then he would have been right in selecting all the guns in question for the service?—Yes.

2638. Then what was the advantage supposed to be gained by the Inspector of Artillery selecting those guns?—That of making a record of every gun received into the service.

2639. But it gave no protection to the service, did it?—There was no responsibility whatever as far as the guns made in the Royal Gun Factory were concerned; not the slightest with regard to the construction of the gun.

2640. Do I understand you to state that when the broad arrow is put upon a gun, when the Inspector of Artillery selects it, and puts it into the hands of the troops, there is no responsibility at all in the duty that he so discharges?—Only that the Inspector of Artillery would think it necessary when he was making his record that he should see the record furnished by the Gun Factory was correct; therefore, he would examine the gun, and if he found there were 10 flaws more in the gun than the Superintendent of the Royal Gun Factory had put in that document, he would have brought it to the notice of the Superintendent, and if the number had been less he would have done the same.

2641. Still the broad arrow being upon the gun, although he had found 10 flaws instead of five, it would have been his duty to put that gun in the hands of the troops?—Decidedly.

2642. Sir *John Hay.*] After Lord Herbert's order, the Inspector of Artillery's duty with regard to the passing of the guns, and the placing of the broad arrow upon them, only applied to guns made by contract?—Just so.

2643. Those guns made in the Woolwich Arsenal no longer required the inspection of the Inspector of Artillery before the broad arrow was placed upon them?—They did not; the Royal Gun Factory did that.

2644. Previous to that order of Lord Herbert's, both the guns made in the Arsenal, and those made by contract, had been inspected by the Inspector of Artillery?—Yes; he put the broad arrow upon them when the guns passed proof.

2645. In both cases?—Yes, in both cases.

2646. But since Lord Herbert's order, he only inspects, and is responsible for the guns which are not made in the Arsenal?—Quite so; and moreover, after Lord Herbert's order, the Superintendent of the Royal Gun Factory took the guns to the proof, proved them as many times as he liked, and examined them as many times as he liked, and the Inspector of Artillery had nothing to say to those guns.

2647. He was relieved by Lord Herbert's order of the responsibility for the guns made in the Arsenal?—Yes.

2648. But he is still responsible for guns not made in the Royal Gun Factory?—Yes.

2649. Mr. *Laird.*] Did you pass any guns that were lined?—Yes, two guns; No. 16, and No. 32, I think.

2650. Did the description which you received from the Royal Gun Factory state that they were lined guns?—No, I had no idea of it. The only notice I had was, that Sir William Armstrong had stated that those guns of his could be repaired, and that a new barrel or a new chamber could be put into the gun.

2651. Then the history of the gun given to you was not correct, if it did not state that it was lined?—I never saw any description of the lining.

2652. I thought you said just now that a history of those guns was given to you, stating how many defects were in them, and that you compared that history with the gun?—Yes.

2653. But it appears that the Superintendent of the Royal Gun Factory did not state that the gun was patched?—Captain Dyer would be better able to give you evidence upon this subject.

2654. Did they give to you a statement that the gun was a lined gun before you passed it?—No, certainly not.

2655. Supposing the broad arrow had not been put upon these guns, would you have been able to ascertain whether they had been lined or not?—It would have been very difficult; if I had known that the manufacture was of that description, I should have tried to make myself acquainted with the process of manufacture.

2656. But if they had not been marked by the Royal Gun Factory, you would not have been able to find out that they were not in accordance with the sealed pattern?—Possibly.

2657. Captain *Jervis.*] At the time when those guns were first made, there was no inspection whatever on the part of the artillery, was there?—Yes.

2658. I think, before Sir James Graham's Committee on the organization of the War Department, it was part of the evidence given that there was no inspection of the guns then delivered?—I am not aware.

2659. On the 31st December 1859, I believe you were appointed Inspector of Artillery, and an officer was ordered, on the 4th of February 1860, to go down to Elswick to inspect the guns made there?—Yes, there was an officer appointed to go to Elswick, for the purpose of looking at the manufacture that was going on there.

2660. I find from Return No. 10, that during the time you carried on the duty of Inspector of Artillery at Woolwich, and inspected the guns made at Woolwich, you inspected 169 guns, and that 19 of them were rejected?—Yes, I suppose that was about the number.

2661. Were any of those guns which you rejected passed again by you into the service?—None of them. I left about that time, and the Royal Gun Factory had to pass them. They had been rejected upon first proof, and they were then dealt with by the Superintendent of the Royal Gun Factory, according to Lord Herbert's order.

2662. Will you be kind enough to look at Appendix No. 22; there were two papers put in by Captain Gordon, the Storekeeper, as evidence of your having passed those guns into the service; will you look at the first paper, signed by Captain Noble, the Assistant Inspector of Artillery, and state whether that paper is any evidence of your having proved the guns named therein?—No, it is no proof at all.

2663. It is said that 10 rounds were fired from certain guns which were then in the service, and which are named according to the several batteries?—Yes; the broad arrow had been placed upon them, and the 10 rounds which were ordered to be fired after they had been received into the service were an experiment in consequence of Sir William Armstrong's application. Some guns at Shoeburyness

Shoeburyness had been undergoing experiments, and it had been found that some small blisters had arisen, and he requested Lord Herbert that he might have 10 fired from those guns after they had been issued to the batteries; and not only had they been issued to the troops, but the ammunition for those very 10 rounds was the ammunition of the service.

2664. Therefore that return is merely to show that the guns in the service stood that number of rounds, with a view of showing whether the guns were blistered, and whether they were affected by the ammunition then in the service?—It was my suggestion (in consequence of having the passing of the projectiles), that we might try by those 10 rounds the fuses and shells, and to see how the carriages also would stand.

2665. Will you be good enough to look at the table printed below that, and state whether that table is not a table of the proofs of certain guns which came from Elswick, certified as coming from Elswick, and not guns manufactured in the arsenal at Woolwich?—Yes; there are seven guns: those referred to in the first line were Elswick guns; the others were from the Royal Gun Factory.

2666. Were those guns sent to the Royal Gun Factory for repair because they had not passed the first proof?—There was an arrangement made with the Elswick Company, that in case of any repair being needed, instead of sending the guns all the way down to Newcastle, they should be repaired in the Royal Gun Factory; and those were guns repaired under that arrangement.

2667. That does not show that you had certified in any way to the first proof of the guns made in the Royal Gun Factory?—Certainly not.

2668. Mr. *Laird.*] Do you know whether any of the 19 guns that you alluded to were passed into the service by Lord Herbert's order?—By the Superintendent of the Royal Gun Factory.

2669. Those 19 guns were afterwards passed?—Yes, I think so.

2670. *Chairman.*] The words used here are "finally proved"?—That phrase "final proof" is a misnomer; it was not the spirit or feeling of Lord Herbert that the guns should be proved at all; it was quite apart from the proof, and the Inspector of Artillery had nothing to do with it.

2671. Colonel *Dunne.*] Then those guns that were lined were possibly the guns that you had rejected before?—I could not say.

2672. At this moment, if guns were returned and repaired, would they be received into the service if they were lined; there is no order to prevent it, is there?—It has been discontinued.

2673. But what is done with those guns that have been returned on account of flaws?—They have been returned to the arsenal, and will be made serviceable again.

2674. Then there is no objection to their being returned to the Royal Gun Factory, and sent back again rendered serviceable?—None at all. The fact is, that the Committee ought to know the beginning of all this, and the great pressure that there was on the Government and on all the departments, the manufacture being in its infancy. We were all trying to do our best to see how the guns would stand; they stood a very severe proof. I do not suppose any gun has ever stood a more severe proof than Sir William Armstrong's; so much so, that now it is reduced.

2675. What is the proof that they were put to originally?—Two rounds with a double service charge and one service shot, and five rounds with a charge of one-sixth the weight of the service shot, and one shot.

2676. That proof is reduced now?—The new proof is two rounds with the service charge, and three rounds with one-sixth of the weight of the service projectile.

2677. Do you consider that sufficient?—Quite.

2678. Has the same test ever been put to any guns of Mr. Whitworth?—I could not say, but I should think it would be about the same; there would be no difference made to him; it would be according to the service charge that he would put to them.

2679. Has any proof ever been put to Mr. Whitworth's guns?—Yes.

2680. Do you think that those guns of Sir William Armstrong have been improved, and that they will be found less liable to burst or open?—There have been a great many improvements since the commencement, but they were never liable to burst.

2681. But would those guns that have been issued recently stand better than the guns of the first manufacture, in your opinion?—The 12-pounders were all made at one time; we have not been making any land service 12-pounders for a long time.

2682. What class of Armstrong gun is now being made?—We are not making any at present, excepting some 70-pounders and 40-pounders and shunt-guns.

2683. Have they stood proof?—They have not been brought into the service.

2684. But have they been subjected to any proof?—The 40-pounders have.

2685. How have they stood it?—Very well, I believe; Captain Dyer would be able to tell you better than I can.

2686. Do you know of any gun that has been in the Artillery service since your time that is superior or equal to the Armstrong gun?—Certainly not, as a field-gun.

2687. You think that they are sufficient for the service at this moment?—Yes, I think so; no doubt there may be improvements made upon them.

2688. Do you find fault with the vent-pieces or the breech-pieces?—They have been very much improved; there has been a very great difficulty in getting metal sufficiently strong to stand, but that has been now got over; I think the 40-pounder vent-pieces scarcely ever go at all.

2689. You think that that difficulty is completely overcome?—As nearly as possible.

2690. Sir *John Hay.*] Have you seen the alteration proposed by Mr. Westley Richards for the service Armstong guns?—I have only seen a model in wood.

2691. Is that alteration adopted yet?—No; it is before the Ordnance Select Committee.

2692. Have you any opinion to give this Committee upon that proposed alteration by Mr. Westley Richards?—No; it seems clever; it seems to keep the gas from coming out.

2693. Do you think that it is a better arrangement than the present one?—I cannot say.

2694. Colonel *Dunn.*] What is the weight of the present 12-pounder Armstrong field gun?—8 cwt.

2695. *Chairman.*] Since what period do you consider that a safe vent-piece has been discovered?—Captain Dyer would be able to tell you much better than I can, because he has been the officer who has been proving them; I have been

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been led to understand that there have been very few failures with the 40-pounder vent-pieces.

2696. You stated that you were satisfied with the present vent-piece, and I want to know when the vent-piece you are satisfied with was first introduced?—Very recently.

2697. Was it during the present year?—No, I think it was last year.

2698. Was it introduced before the 14th November 1862?—They are going on continually improving; in fact, Swedish iron was introduced for the vent-piece.

2699. Captain *Jervis.*] Do you allude to the large natures of guns, or only to the 40-pounders?—The 40-pounder vent-pieces.

2700. Major *O'Reilly.*] Will you state to the Committee whether Mr. M'Kinley and Captain Noble, who have signed these papers in Appendix 22, which were delivered in by Captain Gordon, are officers in your department, or were so at that time?—Yes, at that date they were.

2701. Then, when your subordinate officers make a formal statement, that certain guns had been tested by you, are the Committee to understand that it does not mean that they have been so tested by you?—The fact is that that was an old form, and if we had had any idea that it would have been brought forward, we should have had it altered.

2702. Then in the second Return (B) it is stated that certain guns had been proved in the presence of the Proof Master; does that mean that they had been so proved or not?—After Lord Herbert's order, the Proof Master acted both for contractors' guns and Gun Factory guns.

2703. Can you explain how in your department in future, if entrusted with the general superintendence and inspection of the different manufactures, the public would have any security that a certificate should mean what it states; for instance, that it should mean that a gun has been tested when it says it has been tested?—I can only say that that is an old form, and it was never supposed that it would be brought up in the way it has been. The Inspector of Artillery had his orders, and of course, if he signed his name, he is responsible.

2704. But here he signs his name, and he is not responsible?—It is quite true.

2705. You stated that you had inspected the 12-pounders from No. 1 to No. 169 inclusive?—Yes.

2706. And you also stated that no gun inspected and passed by you was among the number mentioned in Return No. 8 as having failed: will you kindly look at that return, and tell me whether gun No. 160 was passed by you or not?—I could not say; it might so happen that No. 160 went through its first proof, and was rejected.

2707. Was it rejected by you?—I could not say whether it was or not; I only passed 119 out of those guns, and this No. 160 might have been one of those that were rejected by me.

2708. Can you state whether any of those guns that were rejected by you were passed into the service again without passing under your inspection?—Yes.

2709. But I mean without passing your inspection?—Certainly; the superintendent passed all the guns that I rejected.

2710. You cannot state whether No. 160 was passed by you or not?—No, I could not without reference to papers in my office.

2711. Will you look at that point by the next meeting of the Committee?—Yes.

2712. Captain *Jervis.*] You stated that, after the 4th of February 1860, you did not inspect any more guns from the Gun Factory at first proof?—No, nor any proof.

2713. If you will look at that paper (B) to which the honourable Member is referring, you will see that the date is the 25th of June?—Then I had nothing to do with it.

2714. Major *O'Reilly.*] Would the date of its issue prove that it was not inspected by you before going into store?—The date of its receipt into store would do it.

2715. But the honourable and gallant Member has been referring to the date of its issue?—That is a different thing.

2716. If this gun No. 160 was one of the 19 which were rejected by you, and was afterwards passed into the Store Department without further inspection by you, but with what you call its previous history handed to you, would not that previous history state the fact that it was one of the guns formerly rejected by you?—I do not think it would; no, I am almost certain it would not; the superintendent would merely send it into the store as a gun that he had proved.

2717. You are certain that the previous history of the gun would not state that it was one which you had rejected?—I may say that I think I am certain it would not.

2718. Mr. *Beecroft.*] Can you state to the Committee how many service guns, stamped with the broad arrow, have since then proved to be defective?—No.

2719. Mr. *Baring.*] In respect to the general defects that have been complained of in the Armstrong guns, have you considered those defects which have been reported upon?—I have seen the reports.

2720. Do you consider that those defects are any of them of a very serious character?—Not a great many of them.

2721. Are any of those defects small defects, which almost any guns which had seen much service would show?—Yes, of that manufacture.

2722. That is on account of the welding of the iron, is it not?—On account of the welding of the iron.

2723. The powder acting on the weld would naturally show certain small indentations?—Yes; the welding, by the constant firing, would be apt to be brought out more than when it passed proof.

2724. That could only be remedied by having the bore of a different substance, I suppose?—That would be very advisable.

2725. Have you any opinion with regard to the applicability of steel for that purpose at the present time?—I think they are coming very close to it. I think the best gun would be a gun with a steel lining, with the protection of the coil system, which would prevent any danger from bursting.

2726. Why would you prefer the coil rather than steel for strengthening?—The steel has not come to perfection yet; there is a want of uniformity in it. If anything took place in the interior of the barrel, you would have the protection of the hoops.

2727. If the steel was not tough enough it would fly; is that so?—Yes.

2728. And it might give less resistance than the coil for the purpose of outside protection?—We know that the bursting of a steel gun is something more terrific than it is possible to conceive; we have had experience of that with one of Krüpp's steel

steel guns, and in bursting it committed more havoc than almost any gun that we know.

2729. When did that experience with a steel gun occur?—In November 1861.

2730. Therefore, you would naturally feel that great caution was necessary before the introduction of steel for the whole of a gun?—I think so.

2731. That mode of construction (namely, steel firmly strengthened by coils) is precisely what Sir William Armstrong's first system was?—Yes, I think so.

2732. He only abandoned the steel barrel in consequence of the metal not having attained sufficient perfection?—I think so, most likely.

2733. Mr. *Beecroft.*] Is not homogeneous iron a very mild kind of steel?—Yes.

2734. Mr. *Dodson.*] Did the gun of Krüpp's, which you have alluded to as having bursted, burst on being tested with a charge heavier than the usual service charge?—It was something very considerable; but not heavier than that used at that period.

2735. What kind of powder was used with that gun?—Captain Dyer will tell you that.

2736. We have been told that a particular powder is used in the Armstrong guns: are you not aware whether that powder was used in the Krüpp gun or not?—The same description of powder is used for all proofs, and it is not a special powder.

2737. Mr. *Vivian.*] What was the weight of the Krüpp gun?—I think it was a 20-pounder.

2738. But what was the weight of the gun itself?—I could not say.

2739. What charges of powder had it been proved with?—I do not know; the Inspector of Artillery could tell you that.

2740. You only know that such a gun did burst?—Yes.

2741. You do not know the date?—No.

2742. You do not know whether it was supplied by Krüpp to the Government?—Yes.

2743. Who was present at the testing of the gun when it burst?—The Inspector of Artillery no doubt was present.

2744. Then what are your duties at the present moment?—I am Director of Ordnance, and have all the control of the manufacturing department; and also the Ordnance Select Committee's reports all come through me.

2745. Then, as Director of Ordnance, would it not be your duty to inform yourself with respect to the particulars of the bursting of this gun of Krüpp's?—Yes, a report would come to me; but I could not tell the contents of that report from memory.

2746. But is it not at this moment one of the most interesting questions in gunnery, that of the power of resistance offered by steel guns?—Quite so.

2747. Are there other guns of Krüpp's at present at Woolwich?—Yes.

2748. What guns are they?—There are several guns. I could not tell you the exact weight or nature of those guns without referring.

2749. Cannot you give a general idea what number of guns manufactured by Krüpp there are now at Woolwich?—Not without reference.

2750. You do not know whether there are five or ten, or of what size they are?—About three.

2751. Have any of those guns been tried?—I am not certain.

2752. None of those guns have been tried at all?—Some of them may have been tried.

2753. But have you not informed yourself whether any of those guns have been tried at all?—I do not recollect it at this moment.

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2754. No trials have been made with the guns furnished by Krüpp which are now at Woolwich?—It is impossible for me to remember all the details of the numerous experiments.

2755. What is the nature of the manufacture of Krüpp's guns?—There is a peculiar steel used by him.

2756. How are the guns manufactured?—I am not aware. We have an officer (Colonel Dixon) who is sent over for the purpose of getting information on the subject, as well as with regard to the manufacture of steel, in other parts of Prussia.

2757. Did you visit the International Exhibition last year?—Yes.

2758. Did you visit Krüpp's exposition of guns in the Exhibition?—Yes, I saw them.

2759. Did you observe the mode of manufacture there illustrated by various specimens?—Yes.

2760. What was the nature of those specimens?—I could not describe them to you just now.

2761. But I mean, were they hammered or otherwise?—I could not say.

2762. Did you not observe the very large ingots of steel, partly hammered and partly not, and afterwards cut through to show the difference of the fracture?—Yes.

2763. And the different tenacity in the different guns?—Yes.

2764. You are not aware of the particular character of steel which Krüpp employs?—No. I know he does hammer with a very large hammer; and I understand he has the largest hammer in the world.

2765. Now, with regard to homogeneous iron, what is the difference between homogeneous iron and steel?—The homogeneous iron is a softer description of steel; it is steel, but tempered in a peculiar manner. But these are questions that I do not pretend to go into.

2766. I ask you these questions because I understand that you are at this moment, in point of fact, the head of the whole of the manufacturing departments at Woolwich?—Everything relating to the department passes through my hands; I mean the reports.

2767. But I understand that the whole of the manufacturing departments at Woolwich are under your charge?—They are to a certain extent; all the reports come to me. There are certain parts with which I have nothing to do; for instance, the Finance Department and the Contract Department.

2768. I find that in reply to Question 477 of last year's Evidence, this question was put to you, "Will you be so good as to inform us from that paper what your duties are?" And you reply, "Yes; the paper is as follows: 'Instructions for the Director of Ordnance, 8th July 1861. First, the Director of Ordnance is charged with the important duty of advising the Secretary of State upon all questions relating to the supply and efficient maintenance of guns, small arms, ammunition, and other ordnance *matériel*, and of seeing that prompt attention is paid to the orders of the Secretary of State which concern his department.' (The second head has nothing to do with the question I put to you.) '3d. He will decide all questions of detail connected with his duties, and conduct the correspondence relating to such questions.'" However, do I now understand from you that you are not in any way charged with

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with the practical portion of any department at Woolwich?—No.

2769. But merely with office duties, if I may so put it?—Yes, it is more that way.

2770. Then who is responsible for the conduct of the manufacture in each department?—The heads of the different departments are responsible themselves.

2771. Perhaps you would name the heads of departments who are responsible?—The Superintendent of the Royal Laboratory (Colonel Boxer), the Assistant-Superintendent of the Royal Gun Factory at present, and the Superintendent of the Carriage Department.

2772. Those gentlemen are responsible for the carrying on of the manufacture in their different departments?—Yes; you will see in my instructions that I am not to interfere with the interior economy or working of the departments.

2773. But still your duty is to advise the Secretary of State for War upon all questions occurring in these departments, is it not?—Yes.

2774. But it is a very important function of yours to advise the Secretary of State for War with respect to the manufacture of all warlike materials, is it not?—Yes, with respect to all munitions of war.

2775. With regard to the manufacture of guns or any change in the manufacture of guns, you would advise the Secretary of State for War?—Yes, it having previously gone through the Ordnance Select Committee. All inventions and every alteration of manufacture have to pass through the Ordnance Select Committee first.

2776. Then you advise the Secretary of State for War thereon?—Yes.

2777. That is really the first portion of your duty set out in this memorandum?—Yes.

2778. Then, in advising the Secretary of State for War, is it not necessary to become acquainted with the various systems of manufacture adopted in different countries?—Yes.

2779. Now, with respect to the proof-charge, I understand that the extreme powder-charge used in the proof of the Armstrong guns has been one-sixth the weight of the shot?—Yes.

2780. Will you now state the amount of powder that has been commonly used in firing with Mr. Whitworth's gun?—I do not know without reference.

2781. But has not Mr. Whitworth adopted as his charge one-sixth the weight of the shot?—I think he has.

2782. Consequently, Mr. Whitworth's ordinary charge is the same as the highest proof-charge of the service?—Not quite.

2783. Then is it your opinion, as an artillery officer, that it is desirable to prove guns with excessive charges of powder?—No; I have been always very much against it.

2784. Then you think that the old system of proving guns with double charges of powder, or whatever it is, is a wrong one?—I have been always against severe charges of powder.

2785. You consider, probably, that the gun becomes enlarged by such charges: is that so?—Injury is done to the gun.

2786. Take the instance of the brass 12-pounder Whitworth's gun, or any of those guns proved at Shorncliffe; how were those guns proved?—They were proved in the ordinary way, with a double service charge and the service shot.

2787. The brass guns at Shorncliffe having been proved with a double service charge, do you approve of such a proof?—I think it is rather a severe proof.

2788. Would it be calculated to enlarge the bore of the gun in the powder-chamber?—I should think that a severe proof would be likely to do that.

2789. Then the shot subsequently, when the ordinary service charge is used, would occupy a portion of the space originally occupied by the powder?—Just so; but after proof, the powder chamber would be examined, to see if any enlargement had taken place.

2790. Are you aware whether any enlargement did take place in those guns?—I could not say; but I think, if it had been the case, the Inspector of Artillery would have reported to me.

2791. But that is only inferential?—Yes; Captain Dyer would tell you.

2792. You did not think the matter of sufficient interest to inquire into it?—It would not come before me unless it had taken place.

2793. But would not an experiment of that importance come before you as Director of Ordnance?—If the gun passed proof, there would be nothing more said about it; but if there had been any enlargement of the bore of the gun, it would come before me.

2794. Do you consider that the old system of proof is at all applicable to wrought-iron guns?—Do you mean rifled or smooth-bored guns?

2795. Take wrought-iron guns?—Wrought-iron being much stronger than cast-iron, it would be necessary to give it a severe proof.

2796. Have you ever known an instance in which a wrought-iron gun has burst in the proof?—I think there have been some instances, but I could not say just now how many.

2797. Will you mention them?—

[*The Witness subsequently handed in the following Paper:*]

RETURN of Wrought-iron Guns burst at proof.

40-pounder, E. O. C., No. 97.

Proved 5 June 1860, as an unstrengthened gun, with one round of 10 lbs., burst into five pieces at breech; since repaired; now serviceable.

40-pounder, E. O. C., No. 159.

Proved 8 August 1860, as an unstrengthened gun, with three rounds of 10 lbs. and one round of 6¾ lbs., breech blown out; since repaired; now serviceable.

40-pounder, E. O. C., No. 162.

Proved 15 August 1860, as an unstrengthened gun, with one round of 10 lbs., part of breech blown out; since repaired; now serviceable.

40-pounder, E. O. C., No. 188.

Proved 20 August 1860, as an unstrengthened gun, with three rounds of 10 lbs., and five rounds of 6¾ lbs., passed as serviceable; strengthened in Royal Gun Factories, and again proved 2 November 1860, with two rounds of 10 lbs. and

and one of 6¾ lbs., breech blown out; still unserviceable.

6-pounders, R. G. F., Nos. 9, 10, 11 and 18.

Proved 16 October 1860, cracked in the chase (longitudinally).

70-pounder, Whitworth, Homogenous iron.

Cracked in second round, April 1861.

12-pounder, Fisher's Patent, Malleable iron.

Burst second round, October 1856.

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2798. Now the "history" of a gun is a written history, is it not, referring to a number?—Yes.

2799. Are you aware what the system is with respect to small-arms in Her Majesty's Service, with respect to the proof?—Yes; I know they are proved.

2800. But when proved, are not the guns marked?—Yes.

2801. Cannot the proper officer state the history of each small-arm from the mark which exists upon it?—It would be marked immediately after proof.

2802. And if rejected, a certain mark would be put upon it; is that so?—Yes.

2803. The reason why it is rejected is, so to say, marked upon it?—I am not quite certain, but I believe it is so.

2804. That, perhaps, is immaterial; but would it not, in your opinion, be desirable to introduce some such system in regard to wrought-iron ordnance?—When the proof takes place of a wrought-iron gun, the broad arrow is put upon it.

2805. And then, I believe, comes the written history, in which certain flaws are enumerated in the gun?—Yes.

2806. And the attention of the officers using the gun is drawn to those flaws, and they are requested from time to time to take impressions of those flaws?—Yes.

2807. Would it not be quite possible to inscribe upon the gun, in some part which might not attract general attention, but which would be perfectly well known to the officer using the gun, a history of that gun; so that, wherever it might be, its original condition and its present condition might be contrasted?—It would not be very easy to do so on the gun, but the history of the gun is always kept by the officer.

2808. You think that no system of stamping could do that effectually?—No.

2809. But with respect to lined guns, would it not be an assistance to you if the lined guns were marked?—You might put an L upon them.

2810. I understood you to say that you had no means of ascertaining whether a gun had been lined or not?—The manufacturer would know that.

2811. But you, as the inspecting officer inspecting the gun, could not ascertain from any outward sign that a gun had been lined?—When the guns were first manufactured that was the case; since that we know better, and we should now insist upon the manufacturer making it known if it was done. If there were any repairs, we should know what they were.

2812. If there were a certain number of guns (say 50), and you were called upon to pick out those that had been lined or otherwise patched, could you, from any external mark upon those guns, recognise a lined gun?—We might do it sometimes with great scrutiny; but I have seen some guns where it was difficult even with a magnifying-glass to tell. Major-Gen. *A. T. Tulloh.* 11 May 1863.

2813. Would it not be a very material assistance to you if a record of the various alterations or repairs which occurred in those guns existed upon the guns themselves?—It would assist the Inspector of Artillery very much.

2814. Would there be any objection to such a system?—It is actually carried out at present in the Royal Gun Factory, where they make the guns, and furnish the Inspector of Artillery with a report of all the flaws.

2815. But that is a written report, which in no way attaches to the gun; the report may not be present with the gun; is that so?—It is ordered to go with the gun everywhere.

2816. Now, with respect to the vent-pieces, are you at present perfectly satisfied with the vent-piece of the 12-pounder guns?—Yes; I think with the recent manufacture there will be very few accidents.

2817. Perhaps you will be kind enough to define to the Committee what you mean by "recent"?—Within the last year.

2818. Do you mean that very few accidents have occurred with vent-pieces made within the last year?—No, the vent-pieces might have been manufactured a considerable time since; but I mean that the manufacture of vent-pieces since Swedish iron has been introduced appears to be very successful. It has been most exemplified by the vent-pieces for the 40-pounder guns.

2819. But I am asking you with respect to the 12-pounder guns: are you satisfied with the present manufacture of vent-pieces for the 12-pounder guns?—Yes, I think that the advantage of the Swedish iron for vent-pieces for the 12-pounder guns will be very great.

2820. Do I understand you to state, that only a very few accidents have occurred with the vent-pieces manufactured within the last twelve months?—I do not know whether for the 12-pounders they have been manufacturing vent-pieces during the last twelve months; but if the vent-pieces will stand for the 40-pounder, they will stand for the 12-pounder.

2821. Do I then understand you to state, that you infer, from the fact of the vent-pieces manufactured during the last twelve months for the 40-pounders being good, that the vent-pieces which will hereafter be made for the 12-pounder will be successful?—I think they will be very good; I do not say that they will never fail, but that they will be a very great improvement, particularly upon the steel vent-pieces that were originally made.

2822. Then, coming to the larger natures of guns, and taking for instance the 70-pounders, are you satisfied with the vent-pieces for those guns?—We have no experience of the 70-pounders.

2823. Do you consider there is any such advantage in breech-loading cannons, as to render it desirable that their use should be continued in Her Majesty's Service?—The 12-pounder breech-loader is a very safe and good gun, and the 40-pounder breech-loader is also a very good gun, now that the breech-pieces are improved. If you

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are to have breech-loaders, I do not know anything better than our 12-pounders and 40-pounders.

2824. But suppose you could obtain equal accuracy and equal range with a muzzle-loader, would you prefer a muzzle-loader to a breech-loader?—I think I should.

2825. You would prefer a muzzle-loader, you say?—Certainly, if you can have equal range and equal accuracy.

2826. Will you state to the Committee why you would prefer a muzzle-loader to a breech-loader?—There are difficulties about the gas escaping, and the vent-pieces blowing away, and the breech-screws, and things of that kind. However, since the Artillery have got used to them, I do not think they have found any difficulty.

2827. What was the weight of the old 9-pounder service gun?—I think 13 cwt.

2828. What is the weight of the present 12-pounder field-gun?—8 cwt.

2829. Now, is the recoil of the present Armstrong 12-pounder gun greater than that of the 9-pounder service gun?—Yes, slightly.

2830. You do not consider that 8 cwt. is too light for a 12-pounder gun?—No, I think it is a very good weight.

2831. Captain *Jervis.*] The Committee have had before them some evidence from the Storekeeper at Woolwich, Captain Gordon, in which he states, in reply to Question 2093, that a large number of fuses have been ordered to be condemned; is it a fact that fuses to the amount of 45,000 *l.* have been ordered to be broken up?—I think there is some mistake about that, because a good many of those fuses have been ordered to be kept for practice.

2832. The fact being, that though all the fuses were not so perfect as they might now be made, yet all that are issued are to be expended in the service, until the new pattern which has been adopted is issued?—Yes, in practice in the Artillery, until we get new fuses.

2833. Would that be nearly the whole of the quantity made?—Yes; except about 12,000 concussion and perhaps about 2,000 time fuses, as shown in Appendix 37.

2834. The money value of the fuses condemned falls far short of 45,000 *l.*?—Yes; I should think the value of those fuses would be about 2 *s.* apiece.

2835. Major *O'Reilly.*] You have stated that the fuses already issued are to be used for practice until new ones are obtained: when you get the new ones, will the old fuses be used, or will they be broken up?—Those issued will be used. *See* Appendix.

2836. Mr. *Laird.*] In active service?—No, for practice.

2837. Not in active service?—No; of course we should give out the very best for actual service.

2838. Colonel *Dunne.*] Have you, in fact, any other fuse for use on service at this moment?—Yes; we have a new fuse.

2839. Which has been adopted?—Yes; and the only reason why it has not been actually issued is, that there is some little question about the leather-washer.

2840. It is a matter of some trifling alteration?—A very trifling alteration.

2841. Sir *John Hay.*] I presume it is the usual practice for actual service to send the very best fuses that can be got?—Certainly.

2842. Mr. *Vivian.*] Can you state to the Committee what good end would be obtained by permitting the men to practice with unserviceable fuses?—It is merely that it will save the new fuses. It is not correct to say that the old fuses are unserviceable; they are only superseded by better ones; in fact, that word "obsolete" has been wrongly used with regard to those fuses.

2843. In what respect are they unserviceable?—They are not unserviceable.

2844. Then how are they less good than the new fuses?—There were some few defects in the old fuses, which defects, from time to time, have been altered.

2845. Captain *Jervis.*] *Matériel* of war is, like most other things in this world, one that goes on improving from time to time?—Yes.

2846. And, as you go on improving, you adopt the last pattern, I suppose?—Yes.

2847. But still you expend what you have in store, and replace them as you go on?—Yes. Those very fuses have been used with very great success in practice in New Zealand; the men put up a kind of *pah*, on purpose to represent the same sort of thing as is used by the New Zealanders.

2848. With regard to Krüpp's steel gun in the Exhibition of last year, there was in the Exhibition of 1851 one of his steel guns, was there not?—I do not recollect.

2849. The question of steel as a material for guns has been studied for a great many years, and all over Europe, and we have hitherto had no satisfactory solution of it; is not that so?—Yes.

2850. Mr. Whitworth has devoted almost more attention to it than any other gentleman?—Yes.

2851. And this Committee have before them a letter from Messrs. Whitworth and Company, in which they say (you will find it in Appendix 23, and it is dated 2d May 1861): "From the results of the proof trials with this gun, it would appear that homogeneous metal cannot always be depended upon for large barrels, until arrangements can be made for ensuring that they are perfectly annealed. Such arrangements we have already carried out for smaller barrels made of the same material, and we get them when overstrained to enlarge and bulge, and not to burst. At present the homogeneous metal we use for enlarging cannons is necessarily annealed by the makers of the metal, who have not got the proper heating furnaces for the purpose; and we regret to say, that it has not been so regular and uniform as we expected, and as it would be if properly annealed." That being what Mr. Whitworth himself says in May 1861, let me ask you whether up to this time, even amongst those persons who have paid the greatest attention to the subject, the manufacture of steel is still in a very imperfect state?—I should say so.

2852. As Director General of Ordnance, you having very large and multifarious duties to attend to, would it be incompatible with those duties if you were to devote the whole of your attention to this question of steel for guns, which is occupying the attention of large numbers of competent men throughout the whole of civilized Europe?—I could not take up that question except in connexion with other things.

2853. You, therefore, depute that duty to officers and gentlemen connected with the manufactures of this country, who devote their energies to it; and then, when the results come before you in a matured state, you avail yourself of their judgment?—Just so.

2854. Therefore, when the experiments which have been referred to with respect to these steel guns

guns at Woolwich are submitted to you in the report, it will be your duty to submit them to the Secretary of State for War, stating whether you think steel is a material that should be adopted in Her Majesty's Service?—Yes; I believe we shall have a very elaborate report from the Ordnance Select Committee, and then I shall form my own judgment, after making a great many inquiries and taking a great many steps, before I shall be able to approach the Secretary of State.

2855. The subject has occupied the attention of the Steel Plate Committee and the Ordnance Select Committee, and the result of their inquiries upon the subject will be placed before you?—Yes.

2856. Will you explain to the Committee what are the duties of Mr. M'Kinlay as Proof Master at Woolwich; was he not originally a non-commissioned officer; and was not his duty merely to conduct the proof for the Gun Factory, while he did not know what was the effect of a particular charge upon the gun, nor was he allowed to follow up any results?—He was merely an instrument to see that the proof was carried on safely; he was lent for the purpose

2857. He was not the officer who had to bring to you the results of the charge upon the gun?—He had nothing whatever to do with it after Lord Herbert's order.

2858. You have also been asked to explain what benefit an independent inspection would be after the manufacture of an article was complete; but are you not of opinion that it would be of very great advantage if there were an artillery officer at the head of the Gun Factory?—Yes.

2859. In order that he might be responsible for the conformity of the gun to the sealed pattern?—Yes.

2860. You think that the Royal Gun Factory ought to be superintended by an officer of Artillery?—Yes.

2861. And you think it would be an advantage that there should be an independent inspection of all *matériel* made in the Royal Arsenal as well as all *matériel* made by contractors?—I think so in every respect, and I think the trade in particular would benefit by such a system. In fact, there have been complaints from them upon that subject.

2862. *Chairman.*] Did you find any want of such an inspection when you were yourself at the head of one of those departments?—The question was never mooted.

2863. Did not you yourself manufacture and turn out articles that were never complained of?—Sometimes we had a sealed pattern and sometimes not.

2864. But the report of General Dacres before this Committee with regard to all the *matériel* of war that you sent out to Sebastopol is very satisfactory, and I think there was not any complaint made at the time of failures on account of the want of any inspection beside your own, was there?—I never heard the question mooted.

2865. Colonel *Dunne.*] Is it, however, your opinion that inspection is an undesirable thing?—No, I think it is desirable.

2866. Sir *John Hay.*] Is it not the fact that various parts of the same article in *matériel* of war are now made in different departments of Woolwich Arsenal, and that (leaving out of account dependence placed upon the good faith of the officers who are actually at the head of those departments) there is no officer who can bring together those various parts of the same article, so that they may be compared?—I am not aware of two different departments in the Arsenal making two things to be afterwards brought together.

2867. Is it not the fact that the projectile is made in one department, while the gun is made in another?—Yes.

2868. And at present there is no arrangement by which those two articles can be compared together, in such a way that the same individual shall be responsible that both shall accurately fit?—The patterns are sealed by the Ordnance Select Committee.

2869. But supposing those patterns are departed from, there is no one person who can ascertain beforehand the fact of the departure until the two parts of the same thing are brought together in active service?—That would no doubt be a very serious thing.

2870. Then, in order to prevent such a serious occurrence as the gun and the projectile coming into the field without being compared and fitted together by some officer competent to judge of them, do you not think it is desirable that there should be at the head of all the manufacturing departments at Woolwich some one individual who should be responsible for that?—I think that would be very satisfactory.

2871. *Chairman.*] Were you the manufacturer at one of the departments at Woolwich during the Russian war?—Yes, of the carriage manufacture.

2872. Did you hear during the Russian war of any such difficulty arising as has just been put to you by the honourable and gallant Member?—No, I never did.

2873. Therefore, experience seems to be against the view just taken, although theory may be in favour of it; is not that so?—It may be the case.

2874. Taking the experience obtained during the Russian war, it appears that this difficulty never arose?—I am not aware that it ever did.

2875. But if it had arisen, I suppose you would have heard of it?—Most likely.

2876. Then, at all events, the experience gained in the Russian war distinctly shows that the difficulty did not arise?—Just so.

2877. Colonel *Dunne.*] But you do not mean to suggest to the Committee, I suppose, that because the inconvenience indicated did not arise during the Russian war, the system is not a bad one?—No.

2878. You had an inspection of the artillery, did you not, during the Russian war?—The Inspector of Artillery was the Inspector of the Gun Factory.

2879. *Chairman.*] Was there an independent inspection during the Russian war?—No, I am not aware that there was.

2880. Sir *John Hay.*] But since the Russian war, has not this occurred, that in one department, by a slight deviation in size, the calibre of a gun has been slightly reduced, while in another department the size of the projectile for the gun has been slightly increased, for the purpose of reducing the windage, so that when the two things came together, the projectile and the gun were not available for the service?—I have heard that, but I cannot say that I knew it of my own knowledge.

2881. But, under the present system, such a thing might come to pass, might it not?—Yes.

2882. And do you not think it might be desirable to obviate such a possibility as that?—Yes;

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and I think a system of independent inspection would be very satisfactory to the trade. They do not at all fancy that their articles should be inspected, while articles manufactured in the Gun Factory are not inspected.

2883. *Chairman.*] Such things might take place as have been referred to, only during the Russian war they never did occur; is that the state of the case?—I cannot say whether they did or did not.

2884. Major *O'Reilly.*] Could such an occurrence take place without a deviation from the sealed pattern?—No.

2885. What would be the consequence to the head of the department if he deviated from the sealed pattern?—I think he would be very severely dealt with by the War Office.

2886. If such a thing as that had taken place during the Russian war, would it have been likely to come to your knowledge, as Director of Ordnance?—I think it would.

2887. During the Russian war did such a thing come to your knowledge?—I do not at this moment recollect any particular case of the kind.

2888. Captain *Jervis.*] Were there not during the Russian war some mortars which burst in the Black Sea?—Yes; but that was under particular circumstances; the demand for mortars was very great, and we had to go to other parties for them.

2889. Was there not also a complaint with respect to the Lancaster gun during the Russian war?—They were made in the department, under the eye of Mr. Lancaster himself.

2890. And during the last few years have there not been several complaints by the Adjutant General of Artillery with respect to the guns and ammunition issued to him, and more than one memorandum written from his office, pointing out the necessity of independent inspection even for the Government factories?—I cannot say.

2891. *Chairman.*] The mortars which have been referred to were obtained by contract, were they not?—Yes.

2892. Therefore, there was independent inspection with reference to those mortars?—They were contracted for by the Royal Gun Factory.

2893. But they were inspected by an independent person, were they not?—By the head of the Royal Gun Factory.

2894. Therefore a failure took place in an instance where there was that independent inspection, did it not?—Yes, so far as that went.

2895. The independent inspection in that case was not enough to provide against the calamity to which the honourable and gallant Member has just referred?—That would be a very peculiar case, and I do not think it would be a fair one to judge by.

2896. With respect to the Lancaster guns, was not the Lancaster gun in the very process of invention during the time of the Russian war?—It was.

2897. They were endeavouring to improve it from day to day, but they never succeeded, and have not yet succeeded?—Just so.

2898. Therefore the faults in the Lancaster gun were inherent in the gun itself, and were not occasioned by the want of independent inspection?—No; I do not see that that can be brought forward as a case in point at all.

2899. Any of the cases that have been brought forward to show the necessity of independent inspection have entirely failed, have they not?—Those things have not come under my knowledge.

2900. Still you have a complete knowledge of all that took place in the Arsenal during the time that you were at the head of one of the departments, and since that time you have had, as Director of Ordnance, complete information, have you not?—When I was in the Royal Arsenal superintending my particular department, my knowledge was more respecting my own department than any of the others, of course, and many things might have happened of which I had no knowledge whatever.

2901. But I suppose any great failure in any department besides your own would probably have come to your knowledge?—No doubt of it.

2902. Mr. *Laird.*] I think you have stated that, without your having the history of the guns before you, an inspection of those lined guns would not have disclosed the fact that they were lined?—That would have helped me very much.

2903. If the history did not state that the guns were lined, it was not a complete history?—Just so.

2904. An inspection after the manufacture would be of no value if you could not discover the defects of the gun?—It is difficult to detect the linings in some cases, but that does not render the inspection the less necessary.

2905. Do you consider that the inspection should be continuous during the progress of the manufacture?—Yes, partially; I consider that the inspector should know exactly what was going on in the manufactory.

2906. The new inspector appointed at Woolwich does not exercise a continuous inspection, does he?—The regulations are not yet made.

2907. But the proposed inspector would not be able to exercise a continuous inspection of all the manufactures?—I cannot say; the arrangements are not completed yet.

2908. *Chairman.*] According to the evidence of His Royal Highness the Duke of Cambridge, given before this Committee, if the inspector was not to go into the different departments and examine the manufacture as it went on, his inspection would be of very little value when the article was finished; is that so?—I have not seen the evidence of His Royal Highness.

2909. But, in any case, is it the fact that an inspection of articles manufactured in any of the departments at Woolwich would be of very little use unless it were a continuous inspection?—It is not required that the inspection should be quite continuous, but it would be necessary that the inspector should inform himself of what was going on.

2910. Without having a detailed history of the article from the head of each department, an independent inspector would not be able to ascertain if there were defects in the article, would he?—If the guns came from the Gun Factory the Inspector of Artillery had nothing to do but to prove them.

2911. Then the only inspection necessary would, in that case, be the proof and the examination?—When a gun comes for proof the examiner examines it, and takes an impression of the gun before it is proved. The gun is then proved, and if flaws or anything else appear in the way of change in the gun of such a kind that it ought not to be issued, the gun would be rejected by the Inspector of Artillery.

2912. But if the gun had passed proof, then there would be no necessity for any other inspection; is that so?—All the guns must be thoroughly examined by instruments of a very particular kind.

2913. Sir

2913. Sir *John Hay.*] Would the inspector be able to ascertain whether the projectile would enter the gun or not?—Yes.

2914. There is at present no person whose duty it would be to ascertain that, is there?—No.

2915. *Chairman.*] If a gun were made according to the sealed pattern, and the projectile were not made according to the sealed pattern, it would be probable that the projectile would not enter the gun, would it not?—Of course they ought all to conform to pattern.

2916. Captain *Jervis.*] Do you think it a right system that if certain things are obtained by contract, and similar things are made in the Royal Gun Factory, that the head of the Royal Gun Factory should be placed in a position to inspect articles made by contractors?—No; I think it is very objectionable.

2917. If the Horse Guards have made a certain complaint of certain *matériel* of war in the service, which were made in the Royal Gun Factory, the only person they can call upon as responsible for the subject-matter of the complaint is the person who made those articles?—Yes; no independent officer could do that. I should think if there were an independent inspection it would be more satisfactory to the officer in the Royal Gun Factory himself who made the article.

2918. Therefore, that independent inspection is what you want?—Yes.

2919. *Chairman.*] You want it, although you have never practically felt the want of it?—My former evidence only alludes to the Crimean war; I have never heard of any case such as you put.

2920. Mr. *Vivian.*] Who is there that has the same practical knowledge of the *matériel* as the head of the department who manufactures that particular *matériel*?—The inspecting officer, if he was a proper officer, ought to have that knowledge.

2921. *Chairman.*] Then he must go into the department and see the process of manufacture carried on, must he not?—Certainly; every officer of artillery does that.

2922. Then your view is entirely different from that taken by His Royal Highness the Duke of Cambridge with respect to what the inspector ought to do?—I do not know the view of His Royal Highness the Duke of Cambridge.

2923. Mr. *Vivian.*] In fact, I understand you to say that you would not place reliance upon the officer who was at the head of the department?—The responsibility of the manufacture would still be in his hands.

2924. But is it not much better in practice either not to employ a man at all or to place perfect and implicit reliance upon him; and is not that the custom throughout the manufacturing business of these kingdoms?—I cannot say, but I should think a check is required.

2925. Captain *Jervis.*] But are you aware that in the commercial world that is not the practice; that if, for instance, you want a thousand tons of railway iron, it is thought proper that the engineer should see that the way in which they were manufactured before they were delivered?—I do not know; I should think it was likely.

2926. Mr. *Vivian.*] But are you aware that it is not the practice of great companies to place inspectors in manufacturers' works in order to inspect articles when in course of manufacture, but rather to trust to the good name and respectability of the firm they employ; is not that so?—I am not able to say.

2927. Is it not the custom of foreign Governments, rather than English Governments, to place in people's works inspectors, who are very frequently led to pass over little defects in the manufacture?—I do not know.

2928. Mr. *Baring.*] Is it the fact that you, as a Director of Ordnance, would be the adviser of the War Office, and the Secretary of State, with regard to the purchase of materials of War?—Yes.

2929. Would you be prepared to recommend a system under which *matériel* of war should be purchased from contractors, and that no examination should be made of that *matériel*, but that contractors should have entire and complete confidence placed in them with respect to the mode of manufacture?—No.

2930. With respect to Government Departments, you have, I think, said, that no complaints, speaking generally, of articles produced at the Government Departments have reached you?—With respect to the Crimean war, I do not recollect any.

2931. It has so happened that you have had most excellent officers at the head of the different Government Departments at Woolwich; for instance, Colonel Boxer, and others, who have manufactured with great ability the articles committed to their charge?—Yes.

2932. But suppose that, instead of having excellent officers, such as you have had, you had had careless and bad officers at the head of one of those departments, in that case, while there was no independent inspection, no one would have taken care or checked any mistake that might have been committed by that officer?—Just so.

2933. That officer alone would have been personally responsible for his mistake to the War Office?—Yes.

2934. But what satisfaction would it have been to the country that that officer was personally responsible?—It would be a very serious thing.

2935. But under a system of independent inspection, do you consider that any mistake made by a careless officer would be detected?—I think so; that would be the object of placing an independent inspector there.

2936. Therefore, that would be a very great security to the public, would it not?—I think so.

2937. *Chairman.*] Do you really think, speaking from your experience, that it would be possible for a careless and inefficient officer to be at the head of a department at Woolwich without his being very soon found out?—I think there might be great mischief done before he was found out.

2938. Do you consider, for instance, that during the Crimean war, if any one of the officers at the head of the departments at Woolwich had been careless, that is to say, had turned out bad *matériel* of war, he would not have been found out at once?—Now I come to recollect, there were complaints made during the Crimean war, even in my own department.

2939. What was the nature of those complaints?—It was more of the construction than of the bad material.

2940. That is to say, it was a question as to how the ambulance waggons for carrying off the wounded should be constructed?—Yes; from the great rapidity with which things were turned out there was no time to effect improvements.

2941. When those ambulances were sent out, was it not at once found out that they were bad?—They were made upon a plan that the surgeons, and persons of that kind, had not matured.

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2942. Was it not at once found out, and were not complaints at once made?—Yes.

2943. Then do you not think it is a better way of dealing with the difficulty suggested by the Honourable Member whose questions you have just been answering, than when a bad officer is found to be at the head of a department he should be dismissed on the spot?—Yes.

2944. By that means you secure the principle of individual responsibility, which you admit yourself, during a time of great pressure, worked in the most completely satisfactory manner?—That was under particular circumstances. No one knows better than the Right Honourable Member who is the Chairman of this Committee, the great rapidity with which things were turned out during the Crimean war, and I do not recollect complaints being made beyond what I have mentioned.

2945. Sir *John Hay.*] Do you think it would be desirable to leave it to officers and gentlemen engaged in a campaign to discover mistakes, or do you rather think they ought to be found out by independent inspection before the articles are sent away?—I think they ought to be found out before they are sent away.

2946. The very object of the independent inspection would be to ascertain the accuracy of the manufacture of any article before it was placed in the position in which it would be immediately required?—No doubt.

2947. Major *O'Reilly.*] You have stated that you think the public would be protected by independent inspection against the possibility of evil consequences from the existence of a negligent officer at the head of one of the departments?—Yes.

2948. Now, if the independent inspector was himself a negligent man, may I ask you what would become of that protection?—I presume he would have been selected for that purpose, as being the very best person, and as coming as near perfection as you could get him.

2949. Are not the heads of departments selected on a similar principle?—Yes.

2950. Do you consider the result desired would be better obtained by dividing the responsibility?—I think it is better on the whole that there should be a check.

2951. Do you consider that there is an independent inspection of the guns made at Elswick?—Yes.

2952. By whom?—By the inspector.

2953. He is responsible for the guns?—Yes.

2954. In answer to question 564 in the Evidence of Mr. Anderson, I find it stated, that "a good many of the Elswick guns were lined in the same manner,"—that "same manner" being the mode of lining stated to be objectionable. Will you explain to the Committee whether there was independent inspection in the case of that 12-pounder gun?—I am not aware of any 12-pounder gun being lined at all.

2955. Now with respect to gun 160 at question 584, Mr. Anderson was asked, "Does the same number remain on a gun which is altered?" And he answers "Always the same number." And in a previous answer it is stated, that a gun if rejected by the Inspector of Artillery would be sent back to him, and would have the same number on it by which he would know that it was the same gun. If, therefore, this gun, No. 160, was one of the 19 guns rejected by you, would you not know when it came to be issued that it was one of those 19 guns?—If the gun had the same number on it, I should.

2956. Do you think that same number is given in such a case?—I could not say.

2957. But if the same number is given (as is stated by Mr. Anderson) you must have known that No. 160 was either passed by you, or was one of the 19 rejected?—Yes, I should have known had it come to me.

2958. General *Peel.*] Of the number of guns that have been objected to since they were issued for service by the committee, of which Colonel Bingham was president; do you know how many were made at Elswick, and how many in the Royal Gun Factory?—I think it was 76 by the Elswick Company, and 370 from the Royal Gun Factory at Woolwich.

2959. Those made at the Royal Gun Factory, had been issued under the authority of the head of the department, and had not been submitted to any inspection?—During the time I was Inspector of Artillery, 119 of those guns were passed by me.

2960. Was it subsequent to your inspection, that those guns were rejected?—Afterwards; the Royal Gun Factory then took charge of the guns entirely.

2961. It would appear, that there were a greater number of guns objected to which were made at Woolwich than at Elswick?—There must have been, because the greater number of the 12-pounders were made in the Royal Gun Factory.

2962. There does not seem to be much difference in the method of inspection, whether made by the head of the department, or by an independent inspector?—The Inspector of Artillery inspecting the Royal Gun Factory guns is an independent inspector.

2963. Have the guns not always been subjected to an independent inspection?—No.

2964. Many of the guns that were first made at the Royal Arsenal, were not inspected before you were appointed; is that so?—I was there almost at the very beginning, when the Royal Gun Factory was making the 12-pounders.

2965. Do you think that all those guns have passed an inspection independently of the head of the manufactory?—No.

2966. *Chairman.*] Can you state how many of the Elswick guns have been issued for service; have any of them been issued, except to India?—Sixty-seven in all have been issued, inclusive of 31 to India.

2967. I think when you were at the head of the Royal Carriage Department, you were in the habit of inspecting the carriages sent in by contractors, were you not?—Very few of the carriages were sent in by contractors.

2968. There were a great many obtained from Derby, were there not; I mean carriages and all kinds of ambulances?—Yes.

2969. Were you so rigid in the inspection of other peoples' carriages, as you were in the inspection of your own?—About the same, I think.

2970. But would you not rather have passed over any slight defect in the case of another person's carriage, than you would in a case of your own carriage?—No, I do not know that I should.

2971. Mr. Anderson in answer to question 563, giving a reason for there not being so large a proportion of the Elswick guns lined as the Woolwich guns, says, "I will give you the reason, I am very much more rigid in my examination of my own guns, than I should be with other guns." Do you not think that that would be rather a natural feeling for an inspector to have?—I think not.

2972. General *Peel.*] Mr. Anderson is not an inspector of other peoples' guns, is he?—No.

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2973. Mr. *Vivian.*] IN order to take up the examination at the point at which I left off, I will again put question 2616, to you; "Do you approve of the system of manufacture which is at present adopted by the Government at Woolwich"?—I do not.

2974. Will you state your objections to that system; you have before said this, "I believe wrought-iron (that is to say), welded metal is the very worst material you can use for a gun;" will you complete that answer?—I think it is very unfortunate that so much attention has been paid to the manufacture of guns with a material so unfitted for it as wrought-iron. With regard to the welding of the coil, supposing the metal to have a strength of 20 or 22 tons, the weld is found not to have a strength of more than 14 or 15 tons; now the strength of the homogeneous metal which I recommend is about 40 tons, there are no welds, so that the tube must be of course infinitely better if made of homogeneous metal, than if it is made of wrought-iron which is welded. It is highly desirable that the tube of homogeneous metal, should be of the right temper, and that it should be properly manipulated. It is only just now that we are able to manipulate material of a large size properly, but we have not had any difficulty for a long time past in manipulating the metal for the small sizes. Take the 6-pounder gun, for instance; we have had no difficulty whatever with it, or even the 12-pounder gun. This is a rifle barrel (*producing a model*); what we have tried to do with respect to the material, has been to get it sufficiently soft, or well annealed, so that it would, in case of accident, bulge rather than fly to pieces; if it were made of hard steel, not properly annealed, it would fly to pieces the same as a spring when too hard. Now, in this barrel that I hold in my hand, I made an experiment, to show that if I had a projectile a certain distance from the powder, I could injure the barrel; if it had been very hard, it would have flown to pieces, instead of that, it bulges. Something wrong must happen if the projectile is a considerable distance from the powder. In this one you see that the fit of the short piece is very good, and when I push it down a little, as shown on the outside, it is considerably enlarged. I may state, that we have got this metal to such perfection, that if I put in the ordinary charge of powder, and fill it full of lead, and the lead is put in the whole length, and tightly, so that it cannot be driven out, the whole of the explosion will come through the touchhole, and will not injure the barrel, that is, supposing the projectile to be on the top of the powder. There is that strength in the metal that it would not burst the barrel, although it cannot send the projectile out in consequence of its being so long. We have frequently had that experiment, we fill the barrel full of lead, and the explosion comes through the touchhole, without injuring the barrel at all. But on the other hand, with the ordinary bullet, if you put it a certain distance away from the powder, you destroy the gun.

2975. Have you now attained to equal perfection in the use of homogeneous metal for the large guns that you have been describing with respect to the small guns?—I think so, up to a gun with seven inches bore; that is to say, by making the gun in parts—what we term building it up. As I have said, we have no difficulty at all in making 12-pounders solid; but I should not like to go to a very large size at present. Mr. Krupp is so satisfied with his material that he goes to a large size; but although, having very powerful tools, his metal is very good, I think he has not always sufficiently annealed it.

2976. Then you have now attained to the same perfection in the manipulating of homogeneous metal (which is another word for mild steel), in regard to the 7-inch guns that you have been describing in regard to small musket barrels?—Yes.

2977. You have now constructed a 7-inch gun, and can cause that gun, by the improper position of the projectile, to bulge instead of breaking?—Yes, it would bulge instead of breaking to pieces; I may mention that in the case of the building up of a gun we take care that the tube is annealed in the way I described, so that it will bulge rather than fly to pieces; but, we do not anneal the hoops, we keep them harder for strength, so that in case of homogeneous metal for hoops, we have a stronger metal surrounding the tube. If we make a tube of homogeneous metal, and surround it with hoops made from coiled wrought iron, then we have a weaker metal surrounding the stronger; but now, in the case of the homogeneous metal, we have soft homogeneous metal for the tube and a hard homogeneous metal for the hoops. I expect we shall have guns now of great endurance, and that is really the thing we want to find out.

2978. How many 5½-inch guns have you manufactured?—The number manufactured and in progress of manufacture is about 30.

2979. But I mean the number actually manufactured and proved?—I should say about 15.

2980. Have they been proved?—Yes, they have been proved.

2981. With what charges have they been proved?—We generally prove them with about one-fourth more than the regular charge, and generally after firing the ordinary shot we have a shot of double the ordinary length.

2982. That would be how many diameters?—Six diameters.

2983. Your customary proof of your own large guns is either the charge which you recommend them to be commonly fired with or one-fourth more than that, and a shot of double the common length?—Yes.

2984. And you consider that if the gun stands that, it is safe for ordinary service use; is that so?—Yes.

2985. Have you any account of the endurance of any guns which you have furnished to anybody?—No, we have not.

2986. But you have no reason to doubt the fact that those guns will endure; you have confidence in their endurance?—I feel perfectly confident.

2987. Can you give the Committee any instance of a gun of any size made by you which has endured a large number of rounds?—We have fired field-guns 100 rounds with double shot, and fired very rapidly, and the gun has stood very well.

2988. What sized gun was that?—A 6-pounder and a 12-pounder we have proved; we are now proving 70-pounder 5½-inch bore guns; we are giving them an excessive proof now, and we can furnish a return of that next week.

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2989. *Chairman.*] Is the proof going on now?—We are just commencing it.

2990. Would it be desirable, in your opinion, that some independent authority should be present at that proof?—There is a committee which is appointed, and that proof will be going on directly.

2991. It will be going on under their eye?—Yes.

2992. Captain *Jervis.*] Are those 70-pounders going to be proved before this committee; I mean the 5½-inch guns?—Yes.

2993. *Chairman.*] How many guns are you going to prove?—The committee are going to prove three of each size.

2994. Mr. *Vivian.*] What amount of endurance can you give an instance of to the Committee as to how many rounds any of your field guns have stood?—I am not able to say. I have a 12-pounder at Shoeburyness, which I think was delivered in 1860; what number of rounds that gun may have had fired from it, I do not know.

2995. Is that 12-pounder in the service, and in good condition, at this moment?—I believe it is; I have never heard to the contrary.

2996. Do flaws ever occur in your guns?—Yes; there was a flaw in one of the 70-pounders, and there was a committee appointed by the Government to inquire into it. I was of opinion that there had been an accident, and that the shot had been away from the powder; therefore I instituted a number of experiments with a rifled barrel, to show that that was sufficient to account for it. The committee appointed were Mr. Field, of Messrs. Maudslay and Field, Mr. Penn and Mr. Anderson, of Woolwich, and they reported that in their opinion the gun had been fired with the shot away from the powder.

2997. Can you put in a copy of that report?—Yes.

2998. General *Peel.*] Is that the only gun of yours in which flaws have been detected?—The guns at Shorncliffe were brass guns.

2999. Mr. *Vivian.*] From the nature of the metal which you use in the manufacture of your guns, it being a cast metal, I believe flaws do not occur in the same way as with welded metal?—No. Whether it is cast-iron, brass, or homogeneous metal, it is pretty much the same; if the metal is cast, flaws do not occur as they do in the welded material.

3000. When you said that you had produced metal of such a quality that, instead of blowing to pieces in the 70-pounder, it would bulge if the shot was at a certain distance from the powder; I presume, you meant not that you had caused the gun to bulge (because that would be rather a costly experiment), but that if the shot were so placed the gun would bulge?—Yes.

3001. What number of guns are you at present manufacturing?—We have been constantly increasing our manufacture lately; I really could not say.

3002. Can you give an approximation to what number of guns you have now in hand?—About 100.

3003. From what calibre to what calibre?—From what we call the 1-pounder, about 1½ calibre, up to 9 inches.

3004. Can you state how many of each calibre you have in hand?—

3005. You have, in fact, now been speaking from practical experience as a manufacturer of heavy ordnance, and not simply as an inventor, and upon theory or assumption; is that so?—Yes.

3006. You speak from practical knowledge?—Yes, from practical knowledge.

3007. Would you state to the Committee your system of manufacture?—The tube of the gun is made taper, being in the 5½-inch bore gun one inch larger in diameter at the breech end than at the muzzle end; then a series of hoops are made, which are screwed together so as to form another tube; that is put on by hydraulic pressure. Then the requisite tubes follow in the next series in the same way, the difference being, that in the Woolwich manufacture the tube is made parallel, diameter the same at both ends, and the hoops are made of coiled iron of a certain length; the ends are then turned, and are let in one into another, and then welded. The hoops are heated and shrunk on; and so with the next series. They are turned in the lathe parallel, and shrunk on; whereas ours are turned taper and pressed on.

3008. Why do you prefer putting the tubes on by pressure to shrinking them on?—It is more certain in its results.

3009. Can you give to each tube the desired effect upon the interior tube of the gun?—Yes; we take care that in pressing on the first tube it does not diminish the bore. We put on each successive layer a little tighter than the preceding one; so that by those means, when we have built up the gun, we get immense strength.

3010. General *Peel.*] Has the process by which you are manufacturing guns now been submitted to the Ordnance Select Committee?—Yes.

3011. And they will be the best judges of the process, and with regard to the endurance of the the guns?—Yes.

3012. The experiments have not yet taken place?—No.

3013. Mr. *Vivian.*] What change has taken place in the manufacture of homogeneous metal?—There has been no change, except getting larger tools so as to operate upon larger masses; a larger steam hammer; there is no change in the metal itself, or in the mode of melting.

3014. But you now cool the metal very slowly?—Yes, that is in the subsequent process, after it has been finished and hammered; we now anneal it.

3015. How long does it take in annealing?—From three to four weeks.

3016. You now work it hollow, do you not?—Yes; we are casting it hollow, and hammering it on mandrils.

3017. Do you consider that that process toughens the homogeneous metal?—Yes, very much.

3018. In respect of the guns which have been damaged at Shorncliffe, what statement have you to make to the Committee in regard to those guns?—Those guns have been fired; in fact, I saw them fired 100 rounds each, without any lubrication, and without any washing out.

3019. Should you consider that guns so used were fairly used, or that such a process would be liable to damage any guns?—I had no idea that it was possible that 100 rounds could be fired without lubrication from any rifled gun. Any engineer will know that any surfaces that slide one upon another require lubrication.

3020. You think that the experiment has simply resulted in proving the enormous endurance of the brass guns, even when improperly used?—Yes.

3021. You do not think that that experiment has proved that brass guns rifled on your system are likely to be usually made unserviceable?—Not

Not at all; I think it has been no trial at all with regard to what a brass gun fairly tried will bear.

3022. Then, with regard to the proof of those guns, if a double charge of powder was used, would the bore be thereby enlarged?—Undoubtedly it would be enlarged, and permanently injured, I conceive.

3023. So that when the shot came eventually to occupy the position which was occupied by the powder in the proof that shot would be lying in a hollow?—Yes; it would not have its proper bearing.

3024. Which hollow would be continually increased by the impact of the shot in successive discharges?—To some extent it would.

3025. Referring to your last evidence with respect to shell and Shrapnel, are you aware whether shell and Shrapnel were made by Colonel Boxer for the Ordnance Select Committee on that occasion, in order to try those experiments?—I wrote a letter to the War Office asking to be put in communication with Colonel Boxer with regard to the Shrapnel shell, and the application of the fuses. I had had no experience in the manufacture of fuses, and knowing that there was an establishment at Woolwich, and that Colonel Boxer had had great experience, I thought it was much better to avail myself of the knowledge which he had on the subject.

3026. General *Peel.*] What was the date of that application to the War Office?—I do not remember the date, but I should think it would be about 18 months ago.

3027. Then, that does not apply at all to the ammunition that was tried before the Committee that decided between your gun and Sir William Armstrong's?—No.

3028. Mr. *Vivian.*] But Colonel Boxer did in fact manufacture the shrapnel and common shell for your gun?—He made the shrapnel, and had very good results indeed from it.

3029. Then no practical difficulty arises, therefore, in the construction of the shrapnel shell for your gun?—On the contrary, it seems better adapted than any other gun for it.

3030. In the evidence given on your last examination, you explained the first objection made by the Ordnance Select Committee (in page 166 of the Appendix), to your guns, in 1858; will you now explain the second, relating to differences in range in shot and shell?—The shot and shell at the same elevation will probably have some little difference of range; that is the case with all guns. With respect to the accuracy being greater with shot than shell, we have not found that to be the case if the experiment is made on the same day. I can only account for such a result by supposing that there must have been more wind on the day the shell was tried, than on the day when the shot was tried; we have not found any greater inaccuracy from the shell than from the shot.

3031. Will you explain the objection raised with regard to the lubrication?—The Report says "very careful washing and drying were found to be necessary after every round, in order to enable the shot to go home without jamming." I cannot understand about the drying, if there was no lubrication used, leaving the gun wet would be an advantage. It goes on, "Mr. Whitworth has lately provided wads, composed of beeswax and tallow, 27 of which were used, and appeared to answer." I was the first, I believe, to introduce the wax and tallow wad for lubrication, and it has been found quite successful. Those objections that are raised rather show that there could have been very little practice with the gun.

3032. Do you think that round-fronted projectiles are as good as flat-fronted projectiles, for penetration, supposing the momentum to be the same in both cases?—Undoubtedly not; the round-fronted, if fired at a given angle, will glance off, where a flat-fronted will bite; and we had the experiment at Shoeburyness, where the 12-pounder went through a $2\frac{1}{2}$-inch plate, at an angle of 45 degrees; but no round shot would do that.

3033. You would suggest that trials of endurance of the different species of ordnance ought now to be made by the Government, in order to determine what is the best mode of manufacture?—Yes, I think so; I think that is what is now wanted.

3034. General *Peel.*] In answer to Question 2526, you said, "What I complained of was, that I had not an opportunity of being present at the trials between my guns and Sir William Armstrong's"; that was your complaint?—Yes.

3035. Sir William Wiseman, in his examination, was asked at Question 149, "Is it also correctly stated by Mr. Whitworth, that he was not allowed to be present at the trial of his own gun?" to which he answers, "No; I can show from the letter-book, that we have frequently written to Mr. Whitworth, naming the day and place and hour of the trial, and requesting him to name the time that would be most convenient for him to attend." And then he was asked, "Will you put in a copy of those letters?" to which he answers, "I will." Did you ever receive those letters?—I have never received any letter asking me to be present at the trial with the Armstrong gun.

3036. Did you receive any letter from that Committee, informing you of the day and hour that your guns were to be tried, and giving you an opportunity of being present?—When the gun was being tried by itself, previously to the trial between the Armstrong gun and mine.

3037. But that was the Committee who were trying the two guns, who are stated to have sent those letters?—I had a letter from the War Office to say that the Ordnance Select Committee desired to see our works, and what we were doing there, and I expected that the Committee would come down. The Committee did not come down. I received no other letter. I found that the results had taken place without my knowing anything about it.

3038. You never received those letters in which were named the day, and place, and hour of the trial, you being requested to name the time when it would be most convenient for you to attend; is that so?—Not for the trials between the two guns.

3039. But was that the Committee that was appointed to try those two guns?—Yes. I was never present at the trials between the two guns.

3040. But you received notice, and were invited to attend, were you not?—I never received any request to attend the trial between my gun and Sir William Armstrong's.

3041. But you received a notice of the trial, did you not?—No.

3042. *Chairman.*] I understand you to say that you were present at the trials of your own gun that were made by this Committee?—Yes.

3043. But you were never present at the trial of your gun against Sir William Armstrong's, when the two guns were tried together?—Never.

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3044. General *Peel.*] Was there ever any such trial, or were they not separate trials, all of them?—That I do not know, but I expected those trials would take place after they had visited our works.

3045. Do you complain then of not having been present at a trial which you do not know ever took place?—I do not know what trials took place.

3046. They tried your gun, and invited you to be present, and you were present?—Yes; but I was not present at sufficient trials of my gun to enable them to come to any decision.

3047. But you were invited to be present; did you ever reply to those invitations?—To the best of my recollection, I might have been present three or four times.

3048. But were not all the trials separate? Were not the trials of your gun at one time, and the trials of Sir William Armstrong's at another time?—I cannot say; I can only speak of the trials of my own gun.

3049. Then you complain that you were not present at the trials between the two guns?—Yes.

3050. You were invited to be present, and were present, when your own gun was tried, were you not?—To the best of my recollection, not more than on three or four occasions.

3051. But were not you invited, as Sir William Wiseman states in his evidence, as I have quoted it in answer to Question 149?—Very likely I should be.

3052. Mr. *Dodson.*] Was Sir William Armstrong present at any trial of your gun when you were there?—No.

3053. Were you ever invited to attend the trial of Sir William Armstrong's gun?—No.

3054. Did you ever attend such a trial?—No; before Sir William Armstrong's gun was adopted I never saw it.

3055. At the time when your gun was being tried, and Sir William Armstrong's gun was being tried, did you ever see the trial of his gun as well as the trial of your own gun?—No.

3056. And Sir William Armstrong was not present at the trial of your gun?—No.

3057. Captain *Jervis.*] Was it not the rule of the Committee that no inventor should be present at the trial of another inventor's gun?—That I cannot say.

3058. Mr. *Beecroft.*] Were you ever invited to any trial between the two guns, yours and Sir William Armstrong's?—No, never; I never was present at any extended trial of my own gun, to show the accuracy, and range, and every particular.

3059. *Chairman.*] Will you just state, in general terms, what is precisely the complaint which you make?—My complaint is, that I was not present at the trials which I understood were to take place between my gun and Sir William Armstrong's; that I did not know of any such trials; and my gun, I maintain, had not a sufficient number of trials to enable the Committee to come to any conclusion respecting it.

3060. What you object to is, not that you were not present, but that there were not a sufficient number of trials?—I presume that there were trials between Sir William Armstrong's gun and mine, at which I was not present, and was not asked to be present.

3061. Mr. *Beecroft.*] Was Sir William Armstrong present?—That I cannot say.

3062. Captain *Jervis.*] And you do not know whether the guns were ever tried the same day, one against the other?—I do not know.

3063. Did not each gun go through a distinct series of experiments?—There were some trials no doubt; but with my gun they must have been very few in number.

3064. Mr. *Dodson.*] Some of your newly-made guns are about to be tried by the Government, are they not?—Yes.

3065. Have you any arrangement with the Government with respect to the conditions under which they are to be tried?—Yes.

3066. And have you come to a satisfactory understanding with respect to the conditions under which your gun is to be experimented upon?—There is a programme submitted.

3067. With which you are contented?—I leave it entirely to the Committee.

3068. Are you contented or not: do you consider that your gun is now about to receive a fair trial?—I think so.

3069. Mr. *Baring.*] Are you sure about that?—I have no doubt of it.

3070. Mr. *Vivian.*] With respect to those experiments to which you have alluded, at which you were not present, were those the experiments with respect to which this diagram which I hold in my hand was made?—I was not present at the trial, or asked to be present at the trial, which enabled the Committee to form that diagram.

3071. Captain *Jervis.*] Are the diagrams put in by Sir William Wiseman correct representations of your system or not?—No.

3072. Will you put in a diagram which is correct?—Yes.

Jovis, 14° *die Maii*, 1863.

MEMBERS PRESENT:

Mr. Baring.	Capt. Jervis.
Mr. Beecroft.	Mr. Monsell.
Mr. Dodson.	Sir Frederic Smith.
Colonel Dunne.	Mr. Vivian.
Sir John Hay.	Mr. Laird.

THE RIGHT HON. WILLIAM MONSELL, IN THE CHAIR.

HENRY W. S. WHIFFIN, Esq., re-called; and further Examined.

H. W. S. Whiffin, Esq.
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3073. *Chairman.*] YOU hold in your hand some returns which you were asked to prepare?—Yes; I have prepared three statements. The first is a statement showing the cost of certain guns and projectiles obtained from the Elswick Ordnance Company, compared with the rates of those produced at the Royal Gun Factory at Woolwich. The second statement shows the amount of payments to the Elswick Company on account of Armstrong guns and projectiles, and all material connected therewith in each year since their introduction into the service, including all experimental guns and ammunition. The third statement shows the gross amount that has been expended, and the amount of liabilities on existing orders, so far as the same can be ascertained in the manufacture of guns and projectiles on Sir William Armstrong's principle.

3074. Does that include the amount for compensation?—It includes the amount already paid for compensation, and also the amount that is outstanding on that claim, there being a sum not actually paid.

3075. On the award, you mean?—On the award.

3076. I understand you to say that you have made a calculation with respect to what amount all the guns and projectiles that have been supplied to the service would have cost if they had been supplied at the Royal Gun Factory?—It shows the amount that would have been paid for those articles for which we can get a fair standard of comparison.

3077. Have you made any calculation upon that basis with respect to what the whole amount of the saving would have been in that case?—The gross payment that we have made to the Elswick Company, after deducting the amount for compensation, is 965,117 *l.*; and I am able to make a comparison only with respect to 593,275 *l.*, and on that amount it would appear that had the articles been manufactured at the Royal Gun Factory at Woolwich, a saving would have accrued to the public of about 242,173 *l.*, or 40·819 per cent. in favour of the manufactory at Woolwich. (*The Witness handed in three returns.*—Vide *Appendix*).

3078. Is there anything else which you would wish to state to the Committee?—No, that is all.

Captain ANDREW NOBLE, re-called; and further Examined.

Captain *A. Noble.*

3079. *Chairman.*] I THINK you were the secretary of the committee that decided upon the introduction of the Armstrong gun into the service?—I was.

3080. Were you present at all the trials that took place?—At all of them up to a certain date.

3081. Can you state how many trials of the Armstrong gun, and how many trials of the Whitworth gun, there were?—I think Mr. Whitworth's gun was tried altogether about eight or nine times.

3082. And Sir William Armstrong's, how many times was that tried?—Speaking roughly, I think the various experiments would come to about 50; from 45 to 50.

3083. Before the adoption of the gun?—Yes; but that Committee on rifled cannon only recommended the adoption of the gun for field service. I have been referring to the whole of the trials; there were very few trials of Mr. Whitworth's gun subsequently to the report there alluded to.

3084. Will you kindly put in a statement of the date of each trial of each gun?—I can do so, but it would come perhaps more properly from an official source.

3085. Perhaps you will procure it from an official source?—I will do so.

3086. I observe, that in the table of diagrams contained in last year's Report (which table has been already referred to as showing the comparative effects of the different guns), four of the diagrams refer to Mr. Whitworth's gun?—Yes.

3087. Was Mr. Whitworth present at the experiments which resulted in each of those diagrams?—I cannot at this distance of time speak exactly as to whether he was present every day, but I know positively that he was present at some of those trials, and that due notice was always given to him.

3088. What was the date of those experiments?—The date of the experiments varied, I think, from the 15th of September 1858 to the middle of January 1859.

3089. Referring to two of the letters in Appendix No. 25, I think all that they show is, that Mr. Whitworth requested to know when the

Captain *A. Noble.*

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trials would take place, and that he was asked when it would be convenient for him to attend? —Yes.

3090. What resulted from that?—Mr. Whitworth came; but he had been present at the trials prior to the date of this letter.

3091. Could you put in the whole of the correspondence stating on what days he was present, and on what days he was not present?—I do not think that the records of the committee would contain that information; it was not at that time deemed so important to keep a record of the attendance of inventors, but Mr. Whitworth admitted in his last day's evidence, that he was present four or five times; and, as he does admit that, and as there were only seven or eight trials made, it is clear that he must have been present at nearly all the trials that were made. I should say at once, that he was present at all the trials but for the difference between the number of trials and the number of times upon which he admits that he was present. I recollect distinctly his presence upon nearly all the occasions.

3092. Mr. *Vivian.*] That is a matter of recollection extending back to transactions nearly five years old?—Yes.

3093. Would it not, then, be better, as this is a matter in which there is a difference of recollection, that you should put in a statement, showing exactly when Mr. Whitworth was present, and when he was not, and when the trials occurred, and what correspondence preceded the trials?—I believe that the records of the Committee on Rifled Cannon are in the possession of the Ordnance Select Committee, but I know as a fact that we did not make notes at the time whether the inventor was present or not, so that I do not think such a statement could be put in.

3094. Can you not show by the records in the office whether Mr. Whitworth was invited to be present on each occasion or not?—I should think not.

3095. *Chairman.*] Surely there must have been copies kept of all the letters?—No; when the Committee was first started, copies were kept only of letters, which were deemed important.

3096. Were Sir William Armstrong's guns and Mr. Whitworth's guns ever tried against one another on the same day?—No, not at the same time, but they might have been tried the same day.

3097. As a matter of fact, were they tried the same day?—I cannot say without referring.

3098. The records would show that?—The records would show it. There was a rule of the Committee, that no inventor was allowed to be present at the trial of another inventor's gun, and that rule was rigidly adhered to. Sir William Armstrong was never present at the trial of Mr. Whitworth's gun, and Mr. Whitworth was never present at the trial of Sir William Armstrong's gun.

3099. Mr. *Baring.*] Did Mr. Whitworth complain at that time to the committee, that he was not given a sufficient opportunity of being present at the trials?—No; I must repeat, speaking from my own personal knowledge, that there might have been one or two occasions on which he was not present; but I say most distinctly that he was present at nearly the whole of the trials.

3100. Did he address the committee, complaining of information not having been given to him with respect to the trials of his guns, and did he complain of his not being allowed to attend the trial of Sir William Armstrong's guns?—No.

3101. Those complaints were subsequently to the transactions which took place?—Yes; I have only heard of them recently.

3102. *Chairman.*] Mr. Whitworth was asked at Question 3058, "Were you ever invited to any trial between the two guns, yours and Sir William Armstrong's?" and he replied "No, never." That is in accordance with what you state?—Yes; although the performances of the guns were carefully compared, they were never placed side by side and fired one against the other.

3103. Mr. Whitworth then goes on to say, "I never was present at any extended trial of my own gun to show the accuracy and range, and every particular." Have you anything to say upon that?—I may be permitted to point out to the Committee that to compare one gun with another, it is not at all necessary that the two guns should be present side by side. In fact, a fair comparison would be very difficult under those circumstances; the plan is to try one gun first, and then to try the other gun.

3104. But I was referring to the latter part of Mr. Whitworth's answer, "I never was present at any extended trial of my own gun to show the accuracy and range, and every particular." Is that correct?—Mr. Whitworth was present at all those trials with the reservation I have already made.

3105. What was the nature of the trials that were made?—Mr. Whitworth at that time had not a gun of his own construction; he simply had rifled Government blocks of brass and cast iron. For those guns he only provided shot and common shell, without fuses. Now, the reason Sir William Armstrong's gun was tried in a more extended manner than Mr. Whitworth's was because the only two points that we had to determine with Mr. Whitworth's gun were the range, and the accuracy of the shot and shell, and those points were determined; but with Sir William Armstrong's guns there were a great many other points, such as the effect of the Shrapnel shell, whether the fuses acted efficiently, one with the other, and so on. That was the reason why Mr. Whitworth's gun had fewer trials than Sir William Armstrong's.

3106. But would it have been possible for the committee to have all those appliances provided for them at Woolwich, Mr. Whitworth being only an inventor, and not a manufacturer, and having merely rifled according to his system one of the Government blocks?—With time it would have been possible, but it would have taken a very considerable time.

3107. Colonel *Dunne.*] Was it asked for?—We asked Mr. Whitworth for a fuse, and he replied he could not give us one, but recommended that the Government fuse should be modified.

3108. Mr. *Laird.*] But without such an experiment you could not fairly judge of Mr. Whitworth's gun, could you?—I think we could as the gun then existed; I do not mean to say that we could as it now exists.

3109. But if the committee had wished to make as complete a trial of Mr. Whitworth's gun as of Sir William Armstrong's gun, I suppose they could have obtained the means of doing so at Woolwich?—They could have had the fuses elaborated

elaborated for them, but they could not have got them before their trials, the committee being required to report immediately upon the subject.

3110. But the trials of the two guns could not be compared unless they had been made under the same circumstances, could they?—For the performances of the guns that were compared, the trials were made under exactly the same circumstance.

3111. But you did not go to the same extent with Mr. Whitworth's gun as you did with Sir William Armstrong's, because Mr. Whitworth was not prepared to supply the committee with a certain projectile?—The projectiles had to be invented for Mr. Whitworth's gun, and it was not the province of that Committee to invent them.

3112. But they could have been obtained from the Government stores, could they not?—No; they could have been elaborated, but that would have taken many months.

3113. Mr. *Vivian.*] Were those fuses not, in fact, made by Colonel Boxer, for the Whitworth shell?—I believe they were subsequently, but not at that time.

3114. How long subsequently?—I cannot say.

3115. But the same facility existed for making the Shrapnel shells or fuses then which existed subsequently, did it not?—I believe that Colonel Boxer has been at great pains in elaborating both a fuse and a Shrapnel shell for the Whitworth gun, but I do not know whether he has succeeded perfectly.

3116. Was the ground of the rejection of the gun at that time, that no shell or Shrapnel shell was provided by Mr. Whitworth for his gun?—No; the ground of the rejection of the gun was this: that in the points in which we compared the gun with Sir William Armstrong's, it was inferior at that time in every respect. Then Sir William Armstrong's gun had further the advantage that he had a perfect fuse and Shrapnel shell for it, which were considered very important, and there being no point in which Mr. Whitworth's gun had the advantage of Sir William Armstrong's gun, and there being many points in which Sir William Armstrong's gun had the advantage over Mr. Whitworth's gun, the Committee upon those grounds, recommended Sir William Armstrong's.

3117. *Chairman.*] Was Mr. Whitworth's gun, which was tried before that Committee (the gun made from the Government brass block), the same gun which was tried at Shorncliffe?—The projectiles were very different, I believe; the guns were, in essential respects, the same.

3118. Therefore the gun that was fired against Sir William Armstrong's gun, before that Committee, was the same gun that was afterwards tried at Shorncliffe?—I cannot speak positively with regard to that.

3119. Was there any shell fired with the Whitworth gun?—His blind shell was fired.

3120. Colonel *Dunne.*] Not loaded?—No.

3121. Would that account for that Committee saying, "The shot and shell appear also to give very different results, with regard to accuracy, the accuracy of the shot being considerably greater than that of the shell." If the shell had been loaded would it have fired more accurately?—No, I should think not; at all events the difference would have been very trivial.

3122. When Mr. Whitworth submitted his gun, did he ask for more trials than were made by that Committee?—Not to my knowledge.

3123. And everything that he submitted was submitted to experiment; is that so?—Yes.

3124. Then it would have required additional inventions to carry the experiments further?—Yes.

3125. Was it the duty of the Committee to supply them?—No.

3126. Was there any reticence on the part of that Committee with respect to the trial of any thing that was before them from Mr. Whitworth?—None whatever.

3127. Was there any means whatever used to prevent Mr. Whitworth seeing the experiments?—On the contrary, the rules laid down were that every inventor (and there were others besides Sir William Armstrong and Mr. Whitworth) should be informed of the trials of his own gun.

3128. Are the Committee to understand that every information with respect to such trials that could be given, was given to Mr. Whitworth by that Committee?—It was.

3129. You ceased to be the secretary of that Committee shortly afterwards, I think?—Yes.

3130. And your actual information does not go further than the date of your leaving?—I know most of the facts subsequent to my leaving, but the Committee did not exist very long after I left them; the Committee broke up in the middle of January, and I think I left in the middle of December.

3131. *Chairman.*] Is there anything else which you would wish to state to the Committee?—If the Committee will allow me, I should like to draw their attention to Mr. Whitworth's letter, which appeared in the "Times." Mr. Whitworth has been misinformed about three or four material points with respect to the Committee on Rifled Cannon. In the first place, I wish to point out that no programme of the proceedings of that Committee was furnished to any competitor; in the second place, that the guns which were submitted to that Committee were fired and worked entirely by artillerymen, and not by artificers or skilled men; I have already been examined as to the third point, that is to say, whether or not the Committee prevented Mr. Whitworth from being present at the trial of his own gun, but with respect to the fourth point, it appears to be implied in that letter that that Committee had some personal bias toward Sir William Armstrong. Now I may mention that no member of that Committee with the exception of the president (who had only met Sir William Armstrong officially), had even a personal acquaintance with him; and I further do not think that any member of that Committee had even seen the gun before they were called upon to report upon it.

3132. Sir *John Hay.*] Had the Committee any hesitation in deciding which gun should be recommended for the service?—Not the very least; they were perfectly unanimous.

3133. Mr. *Baring.*] I believe you have already been asked a question about these diagrams, but for perfect distinctness, I will again ask you whether Mr. Whitworth is correct in stating that he was not present at the trials on which these diagrams were formed?—No; I have already explained that his misapprehension was, that he thought the guns had been put side by side. The fact is, that he was present at those trials.

3134. Mr. *Vivian.*] There was one shot included in the calculations from which those diagrams

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grams were formed which fell very short of the range. I believe that that shot was included nevertheless in that diagram, was it not?—I cannot speak from memory upon the point, and I do not see that I could even answer that from the notes; but I may state, that in all calculations of this sort, a rule is very generally made to take as much care as possible before the rounds are fired, and every care was taken in that case, so that there should be no mistake, but to be very careful not to strike out any rounds unless some satisfactory reason can be assigned for so doing. It is considered that if you once open the way to the arbitrary striking out of rounds, you can get any results you please.

3135. *Chairman.*] But did not that particular shot take place at a subsequent trial, when Sir William Armstrong's gun and Mr. Whitworth's gun were tried against one another?—I cannot answer that point.

3136. Sir *John Hay.*] Is it the custom with those experimental guns, when a shot happens to be wild, to eliminate it from the data of the calculation?—That would be a most dangerous custom, unless there is some mistake, some such occurrence as the tangent scale sliding down, for instance; if you find the tangent scale slid down subsequently to the round, or if you can give any valid reason, it should be rejected, but not otherwise.

3137. But not in consequence of its being wild?—Certainly not.

3138. Colonel *Dunne.*] Have there not been improvements in the vent-pieces of the Armstrong guns?—Yes; I myself regard the present vent-pieces, up to the 40-pounders inclusive, as perfectly satisfactory.

3139. *Chairman.*] Since what period do you consider them to have been satisfactory?—As regards standing and properly resisting fire, you might, I think, take the 12-pounder as having been satisfactory all along. There have been very few cases of the 12-pounder vent-pieces breaking; but the defect of these vent-pieces was their blowing out, which has been completely remedied.

3140. Colonel *Dunne.*] Then, going beyond the 40-pounders, are the vent-pieces equally satisfactory?—The 100-pounder vent-pieces are not so satisfactory; but great improvements have been made, and I understand that the last vent-pieces which have been made, have been found to stand very well.

3141. Have you had any experience of what are called "lined" guns?—I have seen a report of them.

3142. But they were made in the Royal Gun Factory, were they not?—Yes.

3143. They were not according to the pattern proposed by Sir William Armstrong?—They were merely patched-up guns.

3144. Therefore these patched-up guns would not represent fairly Sir William Armstrong's principle?—Certainly not.

3145. Then do you think it was right to take those guns into the service as Sir William Armstrong's guns?—I think so. The state of the case was this: here was a large quantity of valuable *matériel*, and the first experiments made with these lined guns having been satisfactory, the question was whether the *matériel* should be condemned, or whether the Royal Gun Factory should do the best they could.

3146. You think that was a justifiable experiment?—I think it was a justifiable experiment, which appears to have failed.

3147. You would not, however, recommend the continuation of the use of those guns in the service?—Certainly not.

3148. Nor do you consider the experiment as a fair test of Sir William Armstrong's gun?—No.

3149. Do you think that homogeneous iron in the centre of a gun would be superior to the coil principle, which has been spoken of as Sir William Armstrong's?—The first gun which Sir William Armstrong made had a steel barrel in it of homogeneous metal, which is a very mild steel. The difficulty in the large guns was to get that metal of a satisfactory quality, but I see no advantage in making any other part of the gun, except the barrel, of homogeneous iron or steel.

3150. Do you think that we are sufficiently advanced in homogeneous metal to trust to it in the barrel of the gun?—I think you might do it for the barrel now, but not for the other parts of the gun.

3151. You would not go further than the centre part of the gun?—No.

3152. Do you think that the application of homogeneous metal would be preferable to the present system for the barrels of guns?—It would be preferable, I think, to coils, with regard to the coils for the barrels only.

3153. *Chairman.*] Were there any "lined" or "patched" up guns made at Elswick?—I do not think there were any 12-pounders; I think they lined two 25-pounders at Elswick, but I am not certain.

3154. Colonel *Dunne.*] Were they lined after being found fault with?—I think so.

3155. Were they originally made at Elswick?—I think so.

3156. *Chairman.*] Is there anything further which you wish to state to the Committee?—No.

SIR WILLIAM GEORGE ARMSTRONG, called in; and Examined.

Sir *W. G. Armstrong.*

3157. *Chairman.*] WHAT office did you recently fill in the War Department?—That of Superintendent of the Royal Gun Factory; originally I was Engineer for Rifled Ordnance.

3158. Were the duties of your office as Superintendent of the Royal Gun Factory the same as those that had been discharged by Colonel Wilmot?—Scarcely, perhaps, exactly the same. My duties were, I think, of the nature of engineering duties from the first. I do not think that on my appointment as superintendent, my duties were substantially altered.

3159. But when you were appointed to that office, was there any new Minute or programme, defining in what your duties were to differ from those of Colonel Wilmot?—No; my duties were specified in the first instance as Engineer for Rifled Ordnance; and I think that after the new appointment, they were, at all events, substantially the same.

3160. Were there no new duties indicated to you when you took the superintendence of the Royal Gun Factory?—I cannot recall to my mind at this moment that there were any new duties.

3161. Sir

3161. Sir *John Hay.*] Is the letter dated the 4th November 1859 (just printed in Appendix 36) the letter authorising you to take charge of the Royal Gun Factory?—I received that letter, but the memorandum which defines my duties is another thing, and was in force before the receipt of that letter, and continued in force afterwards. It is at page 177 of last year's Appendix; it is headed, "Definitions of Sir William George Armstrong's duties as Engineer for Rifled Ordnance." That was distinctly kept on foot by a letter which I wrote to the War Office on the subject.

3162. Should you be able to put in that letter?—I will do so.

3163. *Chairman.*] Have you any observations to make to the Committee with respect to the mode in which you would prefer your evidence being taken?—I should wish to run through a brief history of the whole of the transactions, with respect to my system of rifled ordnance, so that the Committee may have before them the entire case, in a compact form. In doing so I must be allowed to refer, very briefly, to some documents which are already in evidence before the Committee, but which I feel are almost buried in the large mass of Appendix. The first paper to which I have occasion to refer, is the War Office Minute at page 156, of last year's Appendix, and which bears date 1st of May 1860. It is there said, "The Armstrong gun was first brought to the notice of the Government in December 1854, when the Duke of Newcastle (then Secretary of State for War), gave Sir William Armstrong (then Mr. Armstrong) an order for a number of his guns, not exceeding six, for trial. The first of these guns, 3-pounder, was delivered in July 1855 (which is about six months afterwards), when Mr. Armstrong forwarded a detailed report (A. annexed) of the experiments he had made, and of the principle of the construction of his gun and projectiles." I may state, that that first gun was completed in March 1855, and that the intervening time between March and July was occupied in my own private experiments. I will now turn to the Report which is here alluded to (it is at page 158), and I will quote a few passages to show what was really the construction of the gun that I then brought forward: "The substitution of elongated solid projectiles for spherical bullets, is an essential step to the attainment of very extended range in artillery practice; but the lengthening of a solid projectile involves the necessity of strengthening the gun, to enable it to resist the greater intensity of force which becomes necessary to give the required velocity, and this object can only be effected, consistently with lightness, by constructing the gun of steel or wrought iron, instead of cast iron or bronze." The Committee will see, therefore, that in the very outset I contemplated a special mode of construction, to render the gun susceptible of rifling. I proceed, in this Report, to give the relative strength of steel and other materials, and then I go on to say, "There is also much uncertainty in the lateral strength of wrought iron or steel, because the flaws or imperfections of welding, which exist in all thick masses of those materials, almost invariably run in the direction of the length, and in general, therefore, only detract from the strength in the transverse direction. It is for these reasons that the barrels of muskets and sporting guns are formed, by twisting long slips of iron into spiral tubes, and then welding together the edges, by which means the longitudinal length of the slips becomes opposed to the explosive force of the powder, and the weldings being transverse with the bore have no important influence in lessening the strength of the barrel." I quote this as showing the original fundamental idea of my system, which was, to form a gun upon the principle of a fowling piece. I then proceed: "The method, however, of forming steel or wrought-iron guns, by simply forging the material into the required form, and boring it in the usual manner, was so much recommended by its facility, that I was induced to make some experiments to test its sufficiency. With this view, a number of cylinders were forged, each 12 inches long, and 5 inches in the outward diameter. These were bored to an internal diameter of $1\frac{3}{4}$ inches, and tested in the following manner." I then proceed to describe the manner in which that was done. "The results obtained in this manner showed, as had been apprehended, great uncertainty in the strength of the material, and rendered it impossible to define the thickness necessary to resist a given charge of powder. I felt compelled, therefore, to dismiss this mode of construction, and to adopt another, more correct in principle, but more difficult of execution." "The mode in which the gun is made up of separate parts, is shown in figure 9, and will be better understood by an inspection of the drawing"—(which is on the following page), "than by any written description. The parts surrounding the steel centre consist of twisted cylinders of wrought iron, made in a similar manner to gun barrels, and, being shrunk upon the steel, they are in that state of initial tension which is necessary to bring their entire strength into operation." I have here a portfolio of the drawings which accompanied that report, and I now produce the drawings of the gun—(*producing a portfolio of drawings*). These show the detailed construction, and the complete gun. The gun is described as having a steel barrel, and the external parts are represented as coil. The mode of breech-loading is also described here. That was the first gun delivered in 1855, which was accompanied by the Report from which I am quoting. This description and these drawings therefore furnish a complete definition of what the gun really was. It was a gun with a steel tube, surrounded with coiled cylinders, similar in every respect to the tubes of gun barrels. Now, the peculiarity of that gun was not its being merely a built-up gun, because built-up guns are of very ancient date. In fact, I have no doubt that the original construction of all guns was by building up. It was not merely a hooped gun, that is to say, a gun strengthened by rings, because rings give only circumferential strength, and no longitudinal strength; but that gun was peculiar in being mainly composed of tubes, or pipes, or cylinders, formed by coiling spirally long bars of iron into tubes, and welding them upon the edges, as is done in gun barrels. Now, whether any one had conceived that idea before, is beyond my power to say, but I feel assured that no gun up to that time had been actually made upon that principle. The whole difficulty lay in the making. It is very easy now, with all our knowledge and experience, to define how such coils are to be made; but at that period, it was a very difficult matter to accomplish, and it was not until I had made very many unsuccessful attempts, that I succeeded in

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in satisfactorily carrying it out. I understand it has been given in evidence that hydraulic presses have for many years been made upon this principle. Now, I think I may state that I know, or ought to know, as much about hydraulic presses as most people, and I will venture to say that prior to the production of that gun (if, indeed, they have ever been made since) no press upon that principle was ever constructed. Of course it was a common thing to strengthen guns, hydraulic presses, and so on, by shrinking rings upon solid castings, but I entirely deny that that is any representation of the principle of my gun. Another feature in this gun is the steel barrel. From the very first I saw, and I still feel, that steel is the proper metal for the barrel of a gun, if it can be obtained, and my only reason for not persevering in the use of steel was the difficulty of getting it of suitable quality. There can be no question that wrought iron is too soft, and that brass is still more objectionable than wrought iron, and if we can only obtain, with certainty and uniformity, steel of the proper quality, there can be no question as to the expediency of using it. Now, no one has any right to appropriate to himself the merit of applying steel to this particular purpose: the merit of its application must rest with the manufacturer who produces a satisfactory article. That has been the great desideratum for many years, and we have been approaching to the accomplishment of it; but up to the present time I am justified in saying that steel has not been produced of a sufficiently uniform quality to render its application expedient. I am quite sure that Mr. Whitworth's experience of what he calls homogeneous iron, as well as my own experience of what I call mild steel (which is really the same thing), is such as to entitle me to say that it would have been exceedingly imprudent to adopt that metal very largely in the construction of guns previously to the present time. I may state also, while I am upon the subject of the material of the gun, that solid forgings of wrought iron have also been tried; that many of my first 100-pounders had internal barrels made of solid blocks of wrought iron, and that those have proved much less satisfactory than coiled barrels. I am satisfied that the only alternative lies between steel and coiled barrels of wrought iron, and the reason of this is very apparent. In the coiled barrel the lines of the welds (I admit that welds are very objectionable in the barrel in all cases), are transverse to the bore. In the barrel, which is forged solid, the lines of the weld run longitudinally with the bore; now we not only derive greater strength from the welds lying transversely to the bore, but we also attain greater durability; because when they run in the direction of the bore, the scour of the gas eats into them, and causes fissures in the most dangerous direction, while in the other case the scour crosses the lines of the welds, and produces very little eroding effect. I am satisfied, therefore, that the coil principle is the only alternative for steel—I mean so far as the barrel is concerned. This principle of constructing the gun of coiled iron tubes is that on which I started, and to which I have always adhered. I began with 3-pounders of 5 cwt., and I have ascended step by step to 600-pounders of 22 tons. Now, whatever question there may be with respect to the originality of the idea, I think it must be conceded that the country has, at all events, obtained through the expenditure that has been made, the development of that principle of construction which is not only very valuable and important, but which has been carried to a much greater extent than there was any reason originally to anticipate. That this system remains the best that is available, is recognised by the fact that every inventor in rifling who wishes to get a gun capable of resisting the highest possible charge, avails himself of it. The safety of the principle I consider has been established by the fact that out of nearly 3,000 guns made on this principle, no one gun has burst explosively, and, in fact, no one gun has failed, under the most trying tests, excepting by a gradual process, which has given timely notice of the approaching destruction of the gun, and has prevented any possibility of a dangerous accident.

To make large guns on the principle of solid forged tubes, either of steel or iron, I consider entirely out of the question, because we never can penetrate the interior of the mass so as to discover the existence of flaws. In the case of steel it is quite difficult enough to get a block sufficiently large to form the mere bore, but if we attempted to obtain a block large enough to form the entire gun, we should enormously increase the difficulty. In the case of wrought iron it is difficult enough even with a block large enough to make the internal barrel to avoid flaws and soft places; and that difficulty would be very much increased if the entire gun was made up of such a mass; in short, I feel perfectly satisfied that the principle of construction which is exemplified in that original gun, is the best that has yet been brought forward, and I see very little prospect of its being superseded. The only question is, whether we can obtain the proper metal for a steel barrel with uniformity of quality. Now, Mr. Whitworth, who is my chief opponent in this matter, admits the propriety of the built-up system as applied to large guns. We are both agreed with respect to the expediency of using the steel tube; but he contends, that the external parts of the guns, as well as the internal parts of the guns, should also be constructed of steel. Upon this point I entirely differ from him. I consider, that although steel is, as he states, very much stronger, in a tensile point of view, yet that it is not so strong as wrought iron as regards concussive strains. The experience of the Iron Plate Committee, as well as my own most vexatious experience, with respect to steel vent-pieces and screws, show that steel, in any form whatever, is more liable to fracture than wrought iron. It is only to be preferred for the bore, because it is harder and closer; but for the external parts, you are much safer with wrought iron. There is no difficulty in making wrought-iron coils, so as to give the requisite strength; and inasmuch as they are cheaper, you can have no inducement whatever to substitute steel cylinders (either united or not united by screws), for the coiled hoops which I have hitherto adopted. Now, to refer again to my report of 1855, at page 163, I state this: "With respect to the construction of heavy ordnance by the process of twisting wrought iron bars into cylinders, and combining them in the manner described, there appears to be no great difficulty in so doing, if proper apparatus be provided for the purpose. It would not, however, be advisable (except in peculiar cases), to apply the principle of loading at the breech, except

cept to guns of small dimensions, because in heavy ordnance the moveable parts would become too cumbrous to be conveniently handled." It will, therefore, be seen, that from the very first I did not pledge myself exclusively to breech-loading guns. I will also read a passage here, which shows, that my views at the time were limited to field guns. I say in that passage, "As a civilian, I speak with diffidence upon the advantages which I believe the long range of this description of field gun will afford in its military application; but I may be permitted to observe, that the incident which chiefly contributed to direct my attention to this subject, still appears to furnish a forcible illustration of its importance. I allude to the memorable service rendered on Inkermann, by means of two 18-pounders, laboriously dragged from the batteries, and ultimately directed with great gallantry and success against the Russian artillery, at a distance from which the numerous, but lighter guns of the enemy could not effectually reply. Now these two battery guns were but a clumsy substitute for light long-range field guns, which would have rendered the same important service with more promptitude and ease, and could have operated at a greater distance from the enemy's fire. It is, perhaps, chiefly as 'guns of position,' commanding important points at great but ascertained distances, that these rifled guns would be valuable, because long range can only be made available where distance can be determined, which it cannot easily be in the rapid operations for which 'field pieces' are employed. It is, therefore as adjuncts to, and not as substitutes for, the present descriptions of field ordnance, that I propose the adoption of these guns; and when fully brought to perfection, I believe they will furnish a most important addition to the artillery of an army." Those were my original views in bringing forward this small gun. Turning back to page 156, you will find this statement—"the whole subject was referred to the Ordnance Select Committee who reported in the main favourably of the gun, though qualified, and desired to make further experiments (B annexed)." Turning to B annexed, which is at page 163, you will find it stated that "neither could common nor Shrapnel shells be fired from a gun of this pattern." Now, I may say, that up to that time I had only contemplated the use of a leaden bullet with this gun, but there appeared so much force in this objection, that I immediately turned my attention to the subject of providing a shell for the gun instead of a simple wrought iron bullet. In the first place, I should say, that the better to adapt the gun for receiving the shell, I re-bored it and increased its diameter, so as to make it a 5-pounder instead of a 3-pounder; I then substituted for the leaden projectile, a cast-iron hollow shot thinly coated with lead, and affixed to that a small percussion fuse so as to make it explode on impact. The gun was then a second time submitted to the Government; and you will perceive in the same memorandum at page 156, a statement that "the gun was re-bored up to a 5-pounder, and, in December 1856, was tried in the presence of Colonel Eardley Wilmot (Superintendent, Royal Gun Factory), near Newcastle, who reported, 30th December 1856, that at 1,500 and 2,000 yards, the gun had made remarkably good practice." The War Office Minute proceeds, "in January 1857, a second gun was ordered to correspond as nearly as possible" (that is to say in weight) "with the service 9-pounder field gun. This gun, an 18-pounder, was reported ready on the 1st of July 1857, and the programme of the trial arranged on the 14th October; but the trial was delayed, owing to Mr. Armstrong's absence on the continent, until the 26th of January 1858, when experiments were made with it in competition with a service 32-pounder gun, which were reported by the Ordnance Select Committee, 5th February 1858 (C. annexed)" (That I need not refer to.) The Minute proceeds, "Colonel Mitchell made a further report on this trial, detailing further experiments, which he desired might be made (D. annexed.) On the 25th of February two 18-pounder guns were ordered, and on the 13th of April, one 12-pounder and 400 projectiles for the 18-pounders were ordered for further experiments. On the 30th of August 1858, General Peel (then Secretary of State for War) appointed a special Committee to ascertain the best form of rifled guns for garison and field service, then known to the War Department. 24th September 1858, one 32-pounder, 26 cwt.; one 12-pounder, 8 cwt.; and one 6-pounder, 3 cwt. Armstrong guns were ordered for trial by this special Committee, which took up the further trial of the Armstrong guns, the result of which will be found in the annexed Report of the Committee, dated 16th of November 1858, in which they recommend the immediate introduction of guns rifled on Mr. Armstrong's principle for special service in the field. In addition to the guns submitted by Mr. Armstrong to this Committee, he also brought before them various new forms of projectiles and fuses, which have since been adopted in the service." Upon the subject of projectiles and fuses, I will observe, that having taken that subject up owing to the objection raised by the Ordnance Select Committee, I was led to inquire into the whole subject. I found that at that time the service projectiles for field artillery consisted of three different forms; first, the solid shot; secondly, the Shrapnel shell; third, common case or canister. Now the disadvantage of having three different projectiles was this, that batteries were liable to expend for any particular service the form of ammunition, which was peculiarly adapted for that service, and were consequently compelled to resort quickly to a form of ammunition which was not adapted for that service. The idea, therefore, occurred to me of adopting a form of projectile which should be convertible, so as to be used either as solid shot, Shrapnel shell, or canister, and this was the origin of the segment shell, in which the arrangement of the segments is made to contribute to the strength of the shell. In so doing, I was enabled to use a shell of a very small thickness, so as to obtain an amount of room which I could not otherwise have obtained for the stowage of the contents of the shell. In this way I produced a shell which for all practical purposes had the solidity of a solid shot, and when used without a burster or a fuse, produced the effect of a solid shot. When used with a percussion fuse, it produced a percussion shell, bursting upon impact; when used with a time fuse, it represented the ordinary Shrapnel shell; and when used with a special adjustment of either the time or the percussion fuse, it could be caused to burst at the muzzle of the gun; in which case it answered the purpose of common case or canister. I was further led into other experiments upon ammunition, which resulted in the

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the production of the various projectiles for the larger guns, and also of the pillar fuse, and of improved patterns of fuses, which have since been adopted. The Rifled Cannon Committee issued their Report on the subject of ammunition on the 16th November 1858, and they observe (page 167), "Mr. Armstrong proposes for his field guns only one projectile, which is capable of being used either as shot, Shrapnel shell, or case. The destructive effects of these projectiles, when used as Shrapnel shells, is very great, as will be seen by the diagrams of the targets accompanying the practice reports, and far exceeds that of any shell in the service. The Committee call special attention to the shell practice (marked No. 34), carried on on the 20th of October, in the presence of his Royal Highness the Commander-in-Chief. Mr. Armstrong has submitted for use with his Shrapnel shell a percussion arrangement, a percussion nozzle, and a time fuse (drawings of which are forwarded). The object of the percussion arrangement is to explode the shell upon striking the ground, or an object, while the percussion nozzle is so arranged, as to explode with readiness upon passing through the slightest obstacle, thus giving great delicacy to the shell. The percussion arrangement can be used alone, or in combination with either the time fuse or percussion nozzle." The Report, as you are aware, was completely in favour of the Armstrong gun and the ammunition; and I really must be allowed to observe, that I do not see how it could possibly be otherwise. The fact was, that no rival system of construction was brought before that Committee, and that there was no rival system of projectiles applicable to rifled ordnance brought before that Committee; therefore, on neither of those subjects could the Committee exercise any choice whatever. The only room for selection was in the mode of rifling; and it is indisputable, that at that time at all events, the best results were obtained by the system of rifling which I had proposed. It may be said, that the Committee might have taken more time; and I would observe, that it would have been infinitely more satisfactory to me, if more time could have been allowed to enable me to perfect all the details of the system which I had proposed. But the urgency of the case was such, that this was impossible. The fact is, that all Europe was, at that time, adopting rifled ordnance, and the greatest anxiety and uneasiness prevailed at the War Office on account of the want of similar arms in our own service. There was, therefore, no alternative, but to decide and proceed at once. It was not so much a question of what the ultimate patterns were to be, as what it was practically to adopt at the time, to give the necessary security. The country obtained its object in getting for its immediate purposes, a system of rifled ordnance which was superior to any that could have been brought against it, and the efficacy of which was proved in the China war. The same threatening aspects of the Continent demanded also that large rifled guns should be procured for naval and siege purposes. I was therefore called upon to produce 40-pounders and 100-pounders without having had any opportunity of testing the patterns by previous trials. Those guns were made, and also the 12-pounders, without having a sealed pattern, simply because time did not permit of a gun being made before we began to manufacture the guns in number. I would also observe here, that in my original Report I stated that I apprehended that the application of breech-loading to large guns would involve an application of parts which would be inconveniently heavy to handle; and in order to obviate that objection I attempted, at the very outset of the manufacture of large guns, to adopt an arrangement of the breech-loading system, which would permit of the part corresponding with the vent-piece, working by a sliding movement from the side instead of being lifted vertically. The first attempt, like, most first attempts, was not fully successful, and there was, therefore, no alternative left but to proceed with the same principle of construction as had been adopted in the small guns; but then, while those larger guns were made on the vent-piece principle, I continued to direct my attention to the side-acting movement, and I eventually matured the arrangement which has since been submitted to the Ordnance Select Committee, and has received their approval. In accordance with the views expressed in my original Report, and feeling that under any circumstances a muzzle-loading gun would be more or less required, I directed my attention so early as 1859 to a system of muzzle-loading rifled ordnance, and I brought forward at that time the system of rifling which has since been designated the shunt system. The object of that system was to afford the means of easy loading from the muzzle, combined with the advantages of a tight-fitting projectile in coming out of the bore. Several guns were made on that principle, and amongst others a large 12-ton gun of the same pattern as the gun which is figured behind me.

3164. *Chairman.*] Will you be good enough to introduce, for the benefit of the unlearned Members of the Committee, an explanation of the shunt principle?—I have always recommended it as essential to accuracy in the projectile, that in issuing from the bore, it should be steady; that there should be no vibration. That object is accomplished in my breech-loading gun by the perfect fit of the lead covering to the grooves of the gun, but it is impossible to have an accurate fit of that kind combined with facility of loading in the muzzle-loader. To obviate that difficulty, and to obtain the advantage of a perfect fit in coming out, I adopted the shunt system. If I had foreseen that I should be asked the question, I would have had a diagram on purpose, but I have in the proceedings of the engineers, a slight sketch which will be of some use in illustrating my explanation. This diagram represents one of the grooves of the gun, and this end to which I am now pointing is the muzzle end; at this point the groove is somewhat wider than it is lower down, and there is a portion here of which so much is marked "incline," and so much "parallel." Here is also a drawing of the projectile, having pieces or slips of soft metal which are let into its body. Now, in the loading of the gun, these projections lie in that portion of the groove which is deeper than the other portion; the consequence is, that the shell has necessarily a degree of play which enables it to enter with ease; the projectile is hugging one side in coming out, and hugging the other side in going down. When it comes to this curve here, it is slightly turned in its course, and follows the narrower groove to the bottom of the bore.

3165. Sir *Frederic Smith.*] Are those soft portions of the shell at all liable to be disturbed?—Not at all.

This leads me to speak of the subject of rifling. I must

I must here state that I do not at all approve of the mechanical fit of hard surfaces. I very greatly prefer using a soft metal, on a projectile which shall be self-adjusting, so that if any part be at all too prominent, that prominent part shall yield and bring all the other parts up to their proper bearing, causing every groove to take its proper share of strain. That plan has also the obvious advantage of saving the bore from any possible injury from friction; and I think also that it has the advantage of avoiding the possibility of there being any choke or jam, from fouling, or any other material lying in the bore. It obviates also the necessity of accurate workmanship, and has all the facility of construction which can be obtained from a tight-fitting projectile. I consider also that the principle of mechanical fit is more objectionable, if it involves any departure from the simple cylindrical form, because the cylindrical form is the most favourable for strength in the gun, and most convenient for the arrangement of the shell. In my breech-loading arrangement the projectile is entirely coated with a thin covering of lead, which is somewhat larger in diameter than the bore, and being introduced from behind, the excess of diameter forms no impediment to its entry. In moving forward in the bore the lead is crushed by the grooves, and moulds itself perfectly to the form. In the shunt arrangement the lead is represented by the soft projections, which in coming out undergo a partial compression, so as to give steadiness, and which mould themselves to the exact form of the gun, and divide the strain equally over the whole; so that both in the breech-loading arrangement and in the shunt arrangement, the same principle of tight fit and soft material for giving rotation are adopted. In the next place, I feel it necessary to make some observations upon the subject of smooth-bored guns as compared with rifled guns, because if it could be shown (and I understand it has been so stated in evidence before this Committee), that smooth-bored guns are really preferable to rifled guns, it would then follow that all the expenditure which has been incurred upon rifled guns has been most truly thrown away. I do not at all regard it as surprising, that lingering partiality should remain in the minds of many distinguished officers in favour of the smooth-bored gun, with which such excellent service has been done for the country on many occasions. The same partialities prevailed in favour of Old Brown Bess; but we all know that the days of Old Brown Bess have passed away, and I have no doubt that the days of smooth-bored guns are also approaching to a close: the fact is, that the introduction of rifled small arms, would alone have necessitated the adoption of rifling for artillery; and that adoption was rendered still more imperative by the fact, that continental nations universally availed themselves of the principle of rifling. The experience of the late Italian campaign, has most distinctly shown that smooth-bored artillery cannot stand against rifled guns; and I believe I am justified in saying, that the success which the French gained over the Austrians in that campaign, was in a high degree attributable to their possession of rifled artillery. The same thing has been established by experiments made at Shoeburyness, in which a number of old guns were set up on the range, surrounded by what are called "dummies," representing a battery, with a detachment of men accompanying it. Such a representative battery has been fired at by smooth-bored guns and by rifled guns, both at short ranges and at long ranges; and it has been found even at short ranges, that the guns have been struck and disabled, and the dummies all perforated by the rifled guns, very much before the same thing could be effected by round shot guns, while at long ranges the smooth-bored guns had no chance at all. I can only say, that the experiments were deemed perfectly conclusive to all persons who took part in them, and that there could be no question whatever of the superiority of rifled artillery over smooth-bored artillery.

3166. Mr. *Vivian.*] Could a report of those experiments be put in?—I have no doubt of it. I understand it has also been stated in this room that the loss of ricochet firing alone, outweighs all the advantages of the rifled principle. On that subject I would observe that a ricochet firing applies almost altogether to solid shot, because the ricochet of a shell is really a matter of little or no importance, and as it is the shell which will undoubtedly be the weapon of future warfare, we have to consider that rather than shot. But, independently of that, I would answer, that at ranges within which the smooth-bored guns are thoroughly effective, the rifled projectile really does ricochet very well. At all events, mine does. There is no difficulty in making a rifled projectile which will do it at a low angle. It is only at high angles that the ricochet firing becomes wild.

It is alleged, also, that these very extensive ranges are of small importance in the field. But I may refer to the experience in China, as showing that rifled guns can be used with great effect at distances far exceeding the range of smooth-bored guns.

3167. Is there any report that we may refer to in regard to what took place in China?—I will undertake to produce evidence to that effect if it is desired; but I wish the Committee to understand that I am now speaking generally of the superiority of rifled over smooth-bored ordnance.

Again, it has been most persistently contended, that the initial velocity of the projectile from a rifled gun (I now speak of large guns rather than of field artillery) is necessarily less than from a smooth-bored gun; but it has been most distinctly established, that where the weight of the projectile and the charge remain the same, the initial velocity with a rifled gun is quite equal to the initial velocity with a smooth-bored gun. But I consider that the greatest advantage of all which is possessed by rifled artillery consists in the greater efficacy of the projectiles which we are enabled to use. I think there can be no question that the destructive effects produced by the 12-pounder segment shell are incomparably greater than can be produced by the shell of the smooth-bored 12-pounder, although the smooth-bored 12-pounder is a gun of twice the weight. That gun, I believe, is now obsolete, but still it has been in use. So also in the larger guns, we find that for the 110-pounder gun, which is a gun of four tons, the bursting charge of the shell is 8 lbs. of powder, while in the 68-pounder smooth-bored gun, which most nearly corresponds with it, and which is 15 cwt. heavier, the bursting charge is only 2 lbs. 12 ozs. Again, the segment shell of the 100-pounder contains 3 lbs. of powder, and is not only greatly superior to the spherical Shrapnell from its greater charge of powder, but also from its general principle of construction, and from the

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greater mass of material which you can use. So also in using molten iron, you are enabled to use a much larger quantity than you can in a spherical projectile. Then, again, in regard to steel shot (with respect to which I am most ready to concede to Mr. Whitworth the merit of very successful investigation), I do not see how you can produce with steel round shot an effect comparable to the effect which can be obtained with cylindrical rifled shot. With respect to employing steel spherical shell, capable of penetrating iron plates, I consider it out of the question. It is only by means of the elongated form of the projectile that we can construct a steel shell capable of piercing an iron plate, and it is due to the principle of rifling that the elongated form can be adopted. In every point of view, therefore, I consider that rifled ordnance, both for field purposes and for battering guns, is greatly superior to smooth-bored ordnance. I feel perfectly satisfied, that whenever smooth-bored ordnance are brought into conflict with rifled ordnance, whether in the field, or at sea, or in siege operations, the former will invariably succumb.

The next subject to which I should like to direct a few observations, is that of breech-loading. Upon the subject of breech-loading for large guns, I would observe that I have no very strong opinion to offer. In my original report I spoke doubtfully; and though afterwards I became more favourable to the system of breech-loading, yet the results of the introduction of armour-plating, and the necessity of combining the greatest possible strength with the least possible weight, have considerably modified my original views. Breech-loading has undoubtedly great advantages. Upon that subject I will quote from my original report at page 162 of the Appendix to last year's evidence: "The advantages of loading at the breech may be stated as follows: 1st. It permits of a bullet being used of a larger diameter than the bore, by which means accuracy of fit is secured, and the material of the bullet is forced into the grooves of the bore. 2d. Any ignited matter remaining in the gun after firing may with ease and certainty be removed, or, if left in the gun, it will be thrust forward from the part where its presence would be dangerous, by the insertion of the succeeding bullet. 3d. In the arrangement which I have adopted, the perishable part of the gun, viz., the vent and its vicinity, is comprised in the moveable breech-piece, which may be easily replaced when worn or otherwise injured. 4th. A rifled gun, loaded at the breech, may be more rapidly fired than a rifled gun loaded at the muzzle, because the fouling of the bore presents no impediment to the insertion of the bullet when introduced from behind; but as compared with smooth-bored ordnance of the ordinary description, there is probably nothing to gain in point of quickness of firing." Those are my original ideas, and to those observations I may add the following: Breech-loading guns can be worked with much less room than muzzle-loading guns. It is not necessary to run back the breech-loading gun so as to give access to it from the front, therefore confined casemates and ships of small beam are enabled to use much heavier ordnance on the breech-loading system than is practicable with the muzzle-loading system. The breech-loading system has also the advantage of dispensing with the necessity of the men going to the front of the gun, and exposing themselves to small arms firing. Those, I think, are the principal observations which I have to offer upon this subject, but there is also the advantage of your being able, in loading from the breech, to send the projectile home to the seat; whereas in loading from the muzzle, the projectile is liable, in case of any obstruction occurring, to be left at a distance in advance of the cartridge, the consequence being, that when the gun is fired, the gas is brought to a sudden stop on arriving at the base of the shot; a condensation is produced at that point which is very liable to burst the gun. There is, therefore, an element of safety in the breech-loading gun which the muzzle-loading gun cannot afford. On the other hand, breech-loading guns of any given power would be heavier than muzzle-loading guns; and now that we are so limited for weight, in order to get the necessary power to produce the required effect upon armour plates, its increase of weight becomes a very formidable objection.

Lunæ, 18° *die Maii*, 1863.

MEMBERS PRESENT:

Mr. Baring.	Mr. Laird.
Mr. Beecroft.	Mr. Monsell.
Lord Robert Cecil.	Major O'Reilly.
Sir John Hay.	Sir Morton Peto.
Marquis of Hartington.	Sir Frederic Smith.
Captain Jervis.	Mr. Vivian.

THE RIGHT HON. WILLIAM MONSELL IN THE CHAIR.

Rear-Admiral SYDNEY DACRES, called in; and Examined.

Rear-Ad. *S. Dacres.*

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3168. *Chairman.*] WHAT appointment do you now hold?—I am Commanding in Chief of the Channel Fleet.

3169. What other appointments have you had?—I have been second in command in the Mediteranean and Captain of the Fleet for the last four years.

3170. And what appointment did you hold before that?—Before that I was Captain of the "Sanspareil," in the Black Sea.

3171. Have you had much experience in the above service with Sir William Armstrong's rifled guns?—Only seeing them at exercise, and firing at targets. In the Mediterranean we had 40-pounder and 100-pounder Armstrong guns.

3172. How many in each ship?—That varied very much.

3173. Were you in the habit of receiving reports of the guns on board your own ships?—Yes, constantly.

3174. Have you formed any opinion with respect to their applicability to the naval service?—Yes; as far as my opinion goes, I should always have the number that the Admiralty allows; that it is a very good proportion; I would not exceed that, certainly.

3175. What proportion is that?—Eight on board an 80-gun ship; about one-tenth of the whole.

3176. Will you state to the Committee your reasons for that opinion?—I should like to have them, because I think the shell is the most destructive weapon that ever was known against wooden ships.

3177. At practice at sea with those guns, is the precision to be depended upon?—Not with their motion; not so much as the others.

3178. For what reason?—I think that the men have greater difficulty about them, and they complain more, and that these difficulties are much more perceptible when the exact range is not known, as, for instance, when working round a target, sail or steam.

3179. But is their complaint reasonable?—I do not know that it is; the guns vary excedingly in firing at sea; occasionally you see magnificent shots, and then you go for a length of time and they fail again.

3180. Does the motion of the ship interfere with the accuracy of the firing?—No; I do not know that it does; but when a ship is in motion, the guns, like any other ordnance, cannot be depended upon.

3181. Can they be as much depended upon as the smooth-bore guns you think?—Yes, I think so.

3182. Did you find any annoyance from escape of gas or other causes, in firing those guns between decks?—Yes.

3183. Will you state to the Committee what they were?—There have been several accidents, and one very serious one on board the "Marlborough," which knocked down the cabins under the poop, started the plank and one of the beams, and knocked everybody down who was at the gun.

3184. How did that accident arise?—They say that it arose from the vent piece not being properly screwed up; but that is always liable to happen, because it has happened on several occasions; in the "Edgar" it happened the same.

3185. Could you give a list of the accidents that have happened in the fleet under your command?—I have sent in returns of all; but I could mention several; I could mention the "Marlborough," Edgar," and "Chanticleer." I cannot recollect any more at this instant.

3186. Perhaps you will put in a list of those accidents?—I cannot get at the papers, but I believe that each case has been, as is especially ordered, reported in detail to the Admiralty.

3187. Did all those accidents arise from the same cause?—They all arose from an escape at the breech, which must be, of course, from the screw not being taut up.

3188. Were there many vent pieces that broke?—Yes, several; one broke on board the "Chanticleer," but two months ago, which took two days in getting it out. That I saw myself.

3189. Was the "Black Prince" under your command at any time?—Yes.

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3190. Do you recollect an accident happening there?—No; I know it did happen, but it was not reported to me.

3191. How does the ricochet act with the elongated shot of rifled guns at sea?—It is uncertain.

3192. Have any flaws in the boxes of any rifled guns under your orders been reported to you?—Yes, one on board the "Queen."

3193. Is there not always a list of the flaws furnished with every Armstrong gun that is put on board ship?—Yes.

3194. Have you observed what effect the firing has in developing those flaws?—The guns are nearly always removed, on the Mediterranean station, directly you have the flaws; at least that was the case in the "Queen."

3195. Were there many guns removed for that reason?—No, I think the "Queen" was the only case.

3196. Do you think that there ought to be a limit to the size and charge of guns for ships?—I should not like to go beyond 100-pounders.

3197. Will you state to the Committee why you would not like to go beyond 100-pounders?—I think that it is the length of the time in loading, and the recoil is very great indeed.

3198. Are you in favour of the breech-loader for naval purposes?—No; but I am very much in favour of rifled guns, and if you want it to last you could not have a rifled gun unless it was a breech-loader. My own idea is that the Whitworth and French guns will not last.

3199. Have you any experience of the Whitworth gun?—No; I have seen them.

3200. But you were never present at any practice with them?—Never in my life.

3201. Are you acquainted with any other kind of rifled guns used in any Army of the continental powers?—No, not personally. I have seen them in exercise; I have seen the Carvolho gun in exercise.

3202. You prefer the breech-loader for naval service?—Yes.

3203. You do that on the assumption then that, in order to have a rifled gun, it must be a breech-loader?—Yes.

3204. You consider that it is desirable to have a certain portion of rifled guns on board every ship, is that so?—Yes.

3205. Mr. *Baring.*] Do you know anything of the French rifled guns?—I have heard the French captains speak of them very often.

3206. Can you state what their general impression was?—They are very much in favour of them.

3207. Have you heard of any of them having burst?—No, not one; but I think they are not likely to tell you if they did. They keep everything of that sort quite back.

3208. Mr. *Vivian.*] Supposing that your fear, with respect to the duration of a rifled gun is not confirmed, would you prefer the breech-loader to the muzzle-loader on board ship?—I should a great deal prefer the muzzle-loader.

3209. From its simplicity?—Yes; that is the only objection I have to the Armstrong gun, the want of simplicity.

3210. Your fear is that the mechanical fitting shot would wear the gun?—Yes; iron against iron will always wear; that is my notion.

3211. But supposing that were so, would it not be easy to coat an oval shot, or an hexagonal shot, with lead?—Yes; but I think it would be liable to tearing as it goes in.

3212. But suppose the gun were made a muzzle-loader, could you not coat a muzzle-loader, a muzzle-loader mechanically fitting shot with lead, precisely in the same manner as they coat the breech-loader shot?—Yes; but I do not think that you could load the gun with such readiness; and another thing is, that it would not fit nearly so loose.

3213. Do you consider the absolute destruction of windage to be a desirable thing in a gun?—Yes.

3214. If you obtained the same range with a gun which has windage that you obtained with a gun that has no windage, would you think that the gun which had windage was the most desirable of the two?—Yes.

3215. So that because you could then ignite the shell?—Yes.

3216. Now, with respect to the flaws in the Armstrong guns; you have stated, that when a gun is supplied, a list of the flaws accompanies it?—Yes.

3217. Do those flaws increase by firing?—I do not know at all; I have never seen a gun with flaws but once, and that was on board the "Queen." It was reported at Malta; I do not believe that the gun was fired after it was discovered.

3218. For broadside guns, is a very long range desirable in your opinion?—No, I think not.

3219. I suppose that guns of high penetrating power are desirable?—Yes, of course. But I do not think that any action would ever be decided at long range.

3220. In order to bombard forts, or at long practice, you would prefer the Armstrong guns?—It would do very little against a fort at long ranges.

3221. At night quarters, is not the breech-loader very undesirable?—I do not know; I think there is always sufficient light for that.

3222. Is there not a considerable flash from the breech-loader?—Yes, a considerable flash with a great deal of smoke, since the new wads, which does not clear off easily.

3223. Is not it calculated to make the men lose their confidence when they see the guns flashing at the breech while there is so much powder about?—No, I think not; the thing that would destroy confidence is the vent piece going.

3224. Is there not a great liability of the vent pieces not being properly screwed up at night quarters?—No, it is not an eyesight question; it is a mechanical matter of so many taps.

Sir WILLIAM GEORGE ARMSTRONG, recalled; and further Examined.

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3225. *Chairman.*] When the Committee separated on Thursday last, you were stating what are considered to be the advantages of breech-loading guns. Will you now be good enough to proceed with your observations?—The next subject I shall proceed to touch upon is the question of large and small bores, because I feel it necessary that the Committee should understand how far the effects produced in penetrating plates may be due to the smallness of the bore, and not to any

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any peculiarity of rifling or other specialiy on the gun. The advantages of small bores are, first, that the projectile of the small bore being of a smaller sectional area, presents a less resistance to the air, and therefore it has a greater range; it has an advantage also in point of penetration, because in penetrating, it has a smaller hole to make, and it is quite clear that the power expended in making a small hole is less than the power expended in making a large hole. On the other hand, the disadvantages are, first, that in penetrating it does less damage; secondly, that a shell of a given weight, adapted for a small barrel, contains less powder or other destructive materials than the corresponding shell for a large bore; thirdly, that the elongated form of the small bore projectile involves an increase of the twist in order to give it stability in flight, and that increase of twist involves greater friction in the gun, and a greater strain upon the parts giving rotation; fourthly, the reduction of the size of the bore diminishes the initial velocity, and the reason why it does so is this: when the charge of powder has exploded behind the projectile, it is almost instantly converted into gas, and as the projectile moves forward, it gradually expands, and continues to exert a diminishing pressure upon the base of the shot. The ultimate velocity given to the shot, therefore, depends in a great measure upon the amount of expansion which the powder undergoes before it ceases to act upon the projectile; for example, if we take two bores of 10 feet long, one bore seven inches in diameter, and the other bore five inches in diameter, we shall have in the case of the 7-inch bore, twice the capacity that we have in the 5-inch bore, or very near it; because the square of 7 being 49, and the square of 5 being 25, we have as nearly as possible that relation between the two capacities. Now I will suppose that the cartridge for the 7-inch gun is 12 inches long; in that case the gas will expand it to tenfold its original volume before the shot quits the muzzle; but in the case of the 5-inch gun, the the same charge of powder would occupy two feet in length, and therefore in expanding and operating on the shot, it would only expand to five times its original volume, because the length of the cartridge is one-fifth of the length of the bore, instead of one-tenth of the length of the bore. It is clear, therefore, that in the small bore, the initial velocity of the projectile must be less than in the large bore, unless you increase the length of the gun. In the case I put, it would be necessary in the small bore to have twice the length of the large bore, in order to obtain from the powder the same amount of propelling force. Now the bore adopted by Mr. Whitworth for a gun of a given weight is less than the bore which I have adopted, and, therefore, from that fact he obtains an increase of penetrating power, but only by sacrificing destructive effect, and by incurring also the disadvantages which I have named. By diminishing the bore with a gun of given weight, he obtains a greater penetrating power, but combined with a less shattering effect. In order to show what my own views on this subject have long been, I will quote from the Proceedings of the Civil Engineers, where I am reported to have stated in 1859: "Although a bore of seven inches has been adopted for the 100-pounder gun, it might be desirable for special purposes, when extreme penetrating power was required, to employ a gun of smaller bore. It was maifest, for example, that a shot of 100 pounds in weight, which delivered its blow upon an area of 20 superficial inches, would exert a greater punching effect than one that operated upon double that area. A small bore was therefore obviously the right thing for piercing thick iron plates, provided shot of steel or homogeneous iron were used, but it remained to be seen whether the expense of such projectiles would not almost prohibit their use." Now, sir, it has frequently been asked, and in fact it has been asked by you as President of this Committee, whether, after all the large expenditure which has been incurred upon this subject, we have yet in the service a gun capable of piercing an armour plate. I will meet this question by asking another, and that is whether up to this day we can define the thickness of the plate, or the strength of the structure which artillerists are called upon to penetrate. I will ask whether we are to consider the "Warrior" structure as the maximum strength that we have to contend against, or whether we have to prepare for such a target as the one submitted the other day at Shoeburyness, consisting of plates seven and a-half inches thick, backed by wood with an internal lining of two inches thick. I would ask also what is to be the capability of future ships for carrying heavy guns; whether we are to have broadside ships which will carry guns of six tons weight, or whether we are to have cupola ships, which will carry 300-pounders, or whether we are to have ships mounting guns on the line of their keel, in which case they will carry even 600-pounders. Until these questions are answered, it is impossible to define what pattern of gun would be required. How could I be expected three years ago to produce a pattern for a gun, the data for defining which do not even now exist?

3226. But is there any gun in existence at present that could at (say) 1000 yards, pierce the "Warrior's" target?—No doubt there are experimental guns that could do it, but there are no such guns in the service, and we have never been in a condition to introduce such guns into the service. It is clear that at the time when I designed my gun it was not my duty to speculate on the kind of armour which was likely to come into use. Everything was as uncertain as could be with respect to the use of iron in ships. The only thing I was called upon to do was to provide guns that should prove efficient against ships and forts, such as then constituted the navies and defences of other countries. But, while I took this view of the subject at that period, I have given constant attention to the subject of guns suitable for operating against armour, and have at this moment in existence, and ready for use, at Shoeburyness, a 6½ ton rifled muzzle-loader, which is intended as a pattern for a broadside gun. I have a 300-pounder muzzle-loader, rifled, of 12 tons, which is designed for such purroses as cupola ships and forts.

3227. Mr. *Vivian.*] What is the calibre of those guns?—The first is 9½ inches, and the other is 10½ inches. I have also a breech-loader rifled gun of 8 tons, adapted for a projectile of 200 lbs., of the calibre of 8½ inches, and which is intended more particularly for casemated defences, and for all purposes for which large breech-loaders are specially desirable. Lastly, I have a 600-pounder rifled muzzle loader of 13½ inches

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inches bore, which is specially designed for forts of the most powerful character, and even for ships, if such modes of construction are adopted as will permit guns of that kind being carried. It cannot therefore be said that I am at all behindhand in providing guns to meet the present problematical state of the question. One of those guns, the 300-pounder of 12 tons, has already been tried by the Iron Plate Committee, and I think I may say it has produced a more decisive effect against structures of this kind than any gun which has been tried. Now, Sir, my opinion upon this subject, with regard to the kind of gun that ought to be used, is this: I consider that the enormous weight of material which iron-plated ships must use for protecting their guns, will limit the armament of guns to a very small number in vessels of that kind. The enormous expense also of the steel projectiles, which alone can be used effectively against such structures, necessitates that the ammunition should be sparingly used. I therefore consider that it will not be sufficient to use small-bored guns and guns of small dimensions generally, which will only have the effect of making small easily-plugged holes. I think it will be absolutely necessary to use guns of a very large calibre, which shall have a great crushing effect, so as to destroy the enemy's ship at a small number of discharges, and with a small expenditure of ammunition. From what I have seen of the experiments at Shoeburyness, I thing nothing less than a bore of 9 inches will be sufficient for this purpose, and I very much doubt whether even that will be adequate. It is said that ships cannot conveniently carry guns of more than six tons weight, but I look upon it as a matter of absolute necessity that they should do so. I think that they must accept the use of large guns as an absolute necessity, and that the proper machinery must be applied for the working of such guns. I have no doubt that if it be taken up as an engineering question, ways and means will be found of using guns of any required weight on board ship.

I understand that the object of the present inquiry is to investigate whether the expenditure which has been incurred during the last few years upon improvements in artillery has been judicious. I would wish now to make a few observations on what I consider to have been the alternative courses which the Government could have pursued. I may fairly say that those who object to the course which has been taken, are bound either to show that no expenditure was necessary, or if necessary, what other course the Government ought to have taken. What I stated in my last day's evidence on the subject of the superiority of rifled over smooth-bored ordnance will, I trust, have satisfied the Committee that a change was really necessary; but I think that the Committee will have difficulty in defining, from any evidence that has been taken before them, what alternative could have been adopted in regard to this expenditure. My original report of 1855 enunciated the necessity of a new mode of construction, to afford the increase of strength that was necessary to enable the principle of rifling to be applied to artillery. Those who deny that necessity must maintain that it was only necessary to rifle the cast iron or brass guns of that period, and those who admit the necessity must show what construction different from the one I proposed ought to have been adopted. Looking through the evidence given before this Committee, I find no advocate for rifling cast iron guns. A very feeble attempt has been made to show that brass is the proper material for rifled ordnance. Mr. Whitworth has certainly propounded a system of construction possessing considerable novelty. He recommends a gun having an interior of steel or homogeneous metal, the external parts also of steel formed in hoops and screwed together. But I would observe that, that construction has never been submitted to the authorities, and it is therefore a matter for the future and not for the past, and has no bearing upon the present issue that I can see. With respect to adopting brass guns, I cannot think, after the experience which has been had of that metal, that anyone would be bold enough to contend that we ought to have adopted brass for our ordnance at the period when the Committee on rifled cannon made that report. I refer to the experience with the brass guns recently supplied by Mr. Whitworth, and which have failed at Shorncliffe, or which have been withdrawn (for I do not wish to use a stronger term than is necessary). I also refer to my own experience with brass, in which I endeavoured to make the internal tube of the gun of brass. I found that the metal was so soft that it actually crushed and drew out in length with the pressure. Now, even in wrought iron, the great objection which I found consisted in its softness: wrought iron, however, is twice as hard as brass, so that if the softness be an objection in wrought iron, that objection must be of much greater weight in reference to brass.

3228. Mr. *Vivian.*] What mixture of brass do you refer to?—I speak of gun metal, which is the only mixture of which we have yet had much experience in connexion with ordnance. Up to the period when the Committee on rifled cannon made their report, Mr. Whitworth had produced no new guns, but had merely rifled the service brass and cast-iron guns. Since that period he has only brought forward, in addition to the guns made for him on the coiled principle at Woolwich, four guns in all composed wholly or partially of homogenous iron, which is his favourite material. Those guns are, the 80-pounder and 12-pounder breech-loaders and two 70-pounders. The 80-pounder gun split after a small number of rounds, certainly under 100, had been fired from it. One of the 70-pounders split at proof, so that there remained only two guns out of the four, for experiments. Mr. Whitworth reported in a letter to the Secretary of State, his own distrust of this homogeneous material, and applied to have a coiled barrel made for his surviving 70-pounder gun. Therefore it certainly cannot be contended, that any one of those guns should be regarded as a model for adoption into the service. At all events, if any such idea is entertained, it ought to be at least distinctly propounded, because I must say that I feel great difficulty in knowing what I am to argue against, and what is brought forward as the alternative course, to the adoption of the gun which I made. I can see no alternative in practice, except to have done as the French have done, that is to say, to be content with brass guns fired with low charges for field service, and guns of cast-iron, strengthened by hoops, for other service. Now, the very fact of this hooped system having been adopted by the French, and the fact also of a considerable expenditure having been incurred

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incurred in this country, in an abortive attempt to adopt it, demand some observations from me. Previously to 1858, several patterns of hooped guns were submitted to the Ordnance Select Committee, but none of them gave results sufficiently satisfactory to lead that Committee to recommend their adoption. In 1860 the French made a sudden effort, which excited considerable alarm in this country, to arm their ships with rifled ordnance. At first they used merely their old 30-pounder guns unstrengthened; but intelligence was afterwards received in England that they had ordered a large number of those guns to be strengthened with hoops preparatorily to rifling them. Now, at that period we were just commencing to make our 40-pounders, and under the circumstances it was quite impossible to make them sufficiently fast to have any large number ready for the purpose of balancing the French guns. It was, therefore, determined (and I think it was the only course to take) to adopt at all risks the principle of hooping. The circumstances did not admit of the delay necessary to try definitively experimental patterns before the guns were proceeded with in large numbers. However, the Ordnance Select Committee were directed to continue their experiments, with a view of coming to a conclusion before hooped guns should be actually introduced into the service. A large number of trials were consequently made by the Ordnance Select Committee, who found that the hooped guns were really scarcely stronger, if at all, than the unhooped guns. In fact, I believe that some of the very highest resistances were obtained with guns that were not strengthened. They, therefore, never arrived at the conclusion that it would be expedient to introduce guns so strengthened into the service. Pending, however, those trials, a large amount of materials was prepared for the purpose of making those guns, and as the guns were eventually not adopted, a great waste of material occurred. Of course, that is very much to be regretted; but I do not see that any other course was open to us at that day. In the meantime, France had directed her thunders against Austria instead of against England, and the alarm having passed over, it was not considered necessary to adopt any exceptional course, and the wrought-iron guns were proceeded with. Now the cause of the failure of cast-iron was found to be entirely independent of the strength of the hoops. I have myself seen a hooped gun of cast-iron burst beneath the hoops, the hoops being so strong that they actually held the broken pieces together, the gas coming through the crevices. It is plain, therefore, that you may place a mountain of hoops upon the exterior of a cast-iron gun, and still it will not be able to resist the action of the powder, the fact being that the nature of the material is such that it fractures by the concussion. The cracks commence in almost microscopic proportions; they are exhibited by taking very delicate impressions; and at Woolwich, where these cracks are of course well-known, they can always predict the probable duration of a gun. After these flaws have begun to show themselves, they go on increasing at every discharge, until at length they yield under the pressure of the gas. If the charge be kept very low, this does not take place, and the gun may be used for a great length of time. But even to this day, the French gun continues to be this hoop gun. It is the 30-pounder gun strengthened by hoops, but the charge for that gun is only 5½ pounds: roughly speaking, the gun is twice the weight of our 40-pounder, and yet the charge is scarcely greater. Those, therefore, who recommend the French guns, must be prepared to concede that the weight of metal necessary to resist the charge should be increased twofold. With respect to getting guns capable of producing the effects which are now requisite against iron plates, the production of such guns by hooping cast-iron is, in my opinion, not to be thought of. The effect contemplated is a very difficult thing to accomplish, even where steel and wrought-iron are used, but to accomplish the same results with cast-iron would, in my opinion, be perfectly out of the question. These observations applying to the French naval and siege gun, I will now proceed to speak of their field gun. The French field gun is of brass. It may be called a 9-pounder, but the charge is only 1 lb. 3 oz.; the projectiles used with it consist of a common shell, a shrapnel shell and common case, so that they still have all the disadvantages of complexity of ammunition to contend with. Now, if brass is to be used at all, it is only for guns of very small size that it is practicable, and then it must be with light charges of powder. The range obtained by the French gun and the initial velocity are very defective. I do not attach very much value to extent of range in the field, but I do attach much importance to a high velocity, because in using a shell the efficacy of the fragments on the bursting of the shell is almost entirely dependent on the velocity possessed by the projectile, and therefore the deficient velocity afforded by the French gun as a field gun is a most serious objection to it. The French gun, however, had gained no publicity until 1859, which was after the Armstrong gun had been adopted into the service; and it was therefore not available as an alternative at the time of which I have been speaking. The Ordnance Select Committee immediately on its becoming known what the construction was, lost no time in making experiments with that gun, and the result showed a very great inferiority of practice in all respects, including range, accuracy, and everything else, as compared with the Armstrong gun; but I should state at the same time that taking the French reports of their practice, the inferiority is very much less; that in fact their official reports represent the accuracy of the gun as very satisfactory, though its range and power are confessedly defective. The Ordnance Select Committee, after fully considering the subject, and also after obtaining all the information they could from abroad, came to the conclusion, without hesitation, that there was at that period no inducement whatever to substitute the French system of construction for that of the rifled gun which had been introduced. Shortly afterwards, in 1861, the two systems were exhibited side by side in the China war. Now, we have no satisfactory information with respect to what the effect of the French guns was in that war, but I am in possession of very definite information with respect to the effect of our own gun. This Committee has before it the reports of military officers, but such reports are mostly of a very dry character, being written rather for the purpose of pointing out particular defects which require correction, than for the purpose of comparing

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rival systems with each other. I will therefore state some facts which have been represented to me by perfectly competent authorities, and in doing so will mention the names of those authorities. In the first place, I would observe that destructiveness is the cardinal virtue of a gun; and the first thing that we have to inquire into in judging of a gun is its power of destruction. I will first speak of the destructive effect of the gun when used in the open field, as a field gun. In an action near Pekin, a body of about 500 Tartar cavalry halted at a distance of about 1,500 yards from some of our guns, where they imagined themselves to be safe. Sir Hope Grant proposed to try the effect of one shot at them, and he accordingly ordered one gun to be fired. The projectile, which was the ordinary segment shell, containing the usual concussion fuse, touched the ground a few yards in front of the Tartars, and burst in the usual manner. The Tartars immediately fled, and left on the ground 13 dead men and three disabled horses, all destroyed by that one shell, which was the only one fired. I state this on the authority of Captain Richard Harrison, of the Royal Engineers, who was standing close by when the shot was fired. I further state, on the authority of Major Millward, who commanded a battery of those guns in China, that he used the guns, with very great effect in the open field at ranges varying from 450 yards to 2,000 yards. He states that the damaging effect of the shells was very great, that the Tartar horses are very thick horses, and that at 1,200 yards he found that the segments had gone completely through them, and left a mark on the off side of the horse, just as if cut out with a knife, as clean as on the near side. The shells and concussion fuzes, he asserts, acted admirably; nothing could be better than the bursting of the shells. He found great benefit in the concussion fuzes from the circumstance that he could pick up the range with great facility because the place where the shell burst was distinctly seen. Next, as to the effect of the guns against Tartar gunners, protected by earth works: Captain Harrison has stated that at a large fortified village called Tangku, there were 16 or 18 gunners of the Tartars killed at one gun. He says that the shells were very destructive against the men behind the parapet. He saw, where the shells struck the parapet, and the men behind were all killed by the Armstrong shell. He says the Armstrong guns were considered terribly effective, and that at the taking of the Taku forts they saved a great deal of loss on our side, and that there were an immense number killed by the Armstrong guns. Captain Harrison, who says this, states that he saw every shot fired by the Armstrong guns against forts in China. I further state, on the authority of Major Milward, that his battery fired into the Taku forts, at the distance of 2,000 yards, and that it was afterwards ascertained that the shell had produced very great effect. All these effects were produced by ammunition of the oldest patterns, which, as may easily be supposed, were very far from perfect. The bursting charges of the shells proved insufficient to break them thoroughly up, and both fuzes and bursters had suffered great deterioration by exposure to damp. The time fuzes, in fact, had been completely spoiled. There cannot, therefore, be a doubt, that the effects obtained in that war would fall greatly short of what would now be realized by the ammunition in its improved form. No such effects as those have ever been claimed for the French artillery, and in fact it is quite impossible to suppose that ammunition such as they used, even if their guns had been equally powerful, was capable of producing comparable effects. On the subject of ammunition, Major Milward has stated that "they were only supplied with one kind of projectile, but that they found a great benefit in having only one kind of ammunition in the battery, because they found that in replenishing the ammunition in the field, they had simply to bring up any limber or any waggon, and empty it into the one they were using, and whenever they put their hands into the limber box, whatever they wanted was at hand." I quote this, as expressing in a soldier's language, the advantages which I had deliberately schemed in designing the convertible projectile now used in our service. On the subject of the capability of the guns to bear rough work, Major Milward has stated that on one occasion his guns had very rough work indeed. They were sent out with a division of the Army over a swamp, the very worst ground possible for artillery. The guns were in fact almost swallowed up, and were covered with mud when brought into action, but no impediment occurred. I believe that nearly 4,000 rounds were fired with the guns in China without any misadventure, except that on two occasions a vent piece was blown out. No one ever suffered any injury in working them, and no one of the guns had ever to be withdrawn, even in a temporarily disabled condition. The officers commanding the batteries deny the stories which have been so industriously circulated, about the lead stripping off. Colonel Barry has stated that on one occasion he fired his guns from 7 o'clock to 2 o'clock, over a wing of the 60th Rifles, under the command of Major Rigo, without any casualty occurring. Colonel Gardiner in his evidence before this Committee, has referred to a passage in Colonel Barry's Report of operations in China, in which it is stated that on the 22d of August, after having bivouacked in the rain at Tangku, the breech screws were nearly jammed with rust. Colonel Gardiner says when he read that, he felt confident in his own mind that "we had got the wrong gun." This was rather an energetic expression to make use of, because it was very obvious that if such an obstruction did exist, it was only necessary to give the breech screw a little more play than was then allowed, a change which has been made with all the guns since that period. As considerable prominence has been given to this subject, and as it has been referred to more than once, I will, in order to controvert it, bring forward some very decisive evidence to the contrary. In the first place, I will refer to a War Office Minute which was put into my hand on Saturday, and which I will read: "War Office. Minute 18 September 1862, forwards for Committee's information an extract of a report (received through Horse Guards) furnished by Major Govan, Royal Artillery, relative to the Armstrong guns employed in the operations against the Taeping rebels at Tsin-poo, Najow, and Tsolin, during the month of May 1862. The guns are said to have been very efficient in their fire against the crenulated walls of brick of the above Chinese towns, and have, without injury, stood a great amount of rough usage in the constant embarking and disembarking in and out of small boats. Two guns

guns were upset into a creek at Najow, when being brought back to their boats in the dark, and the only damage sustained was, the sights of one gun were broken off; the repair was executed next morning." Those are the very guns that were used in China in the former war, so that we have here a continuation of their satisfactory employment. I quote this not only as showing that those same guns are still doing efficient service, but as showing a case in which they were actually upset into the mud, and were fished out without sustaining any injury. However, the most conclusive evidence on that subject is furnished by the Report of the Ordnance Select Committee, of which I hold a copy, and which is on this very subject, of exposure to the weather; and I should have supposed that Colonel Gardner would have been aware of these experiments having been made. The Committee sat on the 19th December 1860. The members present were Colonel St. George, Captain Sir William Wiseman, Colonel Robinson, Colonel Greathead, Colonel Lefroy, and Colonel Campbell. The minute is headed: "Effects of exposure to the weather on Armstrong field-pieces." I need not read the whole of the report, but I will hand it in. The report says: —"As a preliminary measure, a new 12-pounder gun, No. 8, was demanded from the principal military storekeeper, and was left exposed to the weather, without any protection, and untouched, in the courtyard of the Committee's house, from 3d September to 17th October—a period of 45 days. It rained very constantly during this period, which is longer than it is ever likely to be necessary to leave guns unattended to. At the expiration of it, it was taken to the marshes and fired, without being cleaned or sponged, and its shooting properties, as far as dependent on the velocity of the shot, were ascertained by means of Navez's electro-ballastic apparatus." Then follows the description of the state of the gun. The condition of the gun was as follows:—"Exterior very rusty, all the browning eaten away, bore rusty for a few inches from the muzzle, but clean beyond that distance; breech screw rusty at each end, but the rust did not extend beyond the exterior threads. Vent piece rusty, with verdegris on the copper face. Elevating screw, tappet ring, and handles, very rusty. In this state, and without any cleaning or sponging, the gun was fired, and it is a satisfactory proof that these superficial injuries affect its real properties very little, that the mean initial velocity deduced by Captain Noble from 13 rounds is only 14·2 feet per second less than that deduced from comparative practice with a standard gun. The results were: standard gun, No. 224, 1,141·8 feet; exposed gun, No. 8, 1,127·6. The uniformity of the results was, as it happened, actually greater with the exposed than the standard gun, and the average precision greater in the same ratio." Then follows the comparison of accuracy, which is a little in favour of the exposed gun, that being, of course, accidental. The gun was subsequently examined in the Royal Gun Factories, who reported that there was nothing the matter with it. "The Committee's experience upon this occasion is in accordance with that of the Superintendent of the School of Gunnery, who states that 'none of the guns at Shoeburyness have deteriorated in the least degree from any exposure to which they have been subjected.' He adds: 'Although rust is sometimes allowed to accumulate on the guns, from their being exposed to the weather, they have always been cleaned before being used for practice. This operation is easily performed.' Reviewing the above facts, the Committee have pleasure in expressing their conviction that there is nothing in the structure of the Armstrong gun to render it unsuitable for actual service, either in the field or in the trenches; that it requires no more care than can easily be given to it under all circumstances; and that the superficial rust, which sometimes cannot be prevented from forming, is only detrimental when suffered to accumulate to a degree which is inconsistent with any responsible oversight." I may observe, in addition to that, that it is now the practice at Shoeburyness not even to clean the guns at all after firing; that they merely screw up the vent pieces, put the plug into the muzzle, and when the gun is again used, it is found that the first discharge clears every thing away, the deposit having been softened in the meantime. Of course, if they were to put the gun away for a few days at a time, they would then clean it, but when in frequent use it is not necessary to clean the gun at all. I think, referring to what I have stated with respect to the China campaign, and to this circumstance also, as connected with that campaign, there is no room to contend that the Government would have acted more wisely than they have done if they had pursued the course which has been adopted in France with respect to field artillery.

In considering this subject of alternative courses, a clear distinction ought to be preserved between the question of what is now the best gun and what was the best gun available at the time the choice was made. I am quite ready to enter upon the question of what is now at this moment the best gun, but I should certainly imagine that this Committee would feel a difficulty in coming to any conclusion on that subject, unless it constituted itself an experimental Committee. With respect to the past, it is not a question whether the Armstrong system, adopted in 1858, was a perfect system, and whether it was exempt from defects; but it is a question whether it was the best that was available at that time. Perhaps it may also be said to be a question whether the defects and the failures which have arisen are attributable to want of proper and reasonable foresight and vigilance, or whether they are such as may be fairly looked upon as necessarily incidental to the introduction, under such circumstances, of any extensive new system. Now, upon this question, I would refer to the sacrifices which have been incurred in connexion with the introduction of rifled small arms. I cannot give the full particulars of them, but I know that before the Enfield pattern was arrived at it was found necessary to sacrifice thousands of rifled muskets made on previous patterns, and also ammunition to a very large amount indeed. And even now, the perfection of the pattern is matter of controversy, and it is, by many persons, denied that the Enfield weapon is yet the best that can be adopted. Now if there be so much difficulty in the case of small arms, where we have only to consider one calibre and one projectile, I think it must be admitted in the case of artillery where you have a vast number of calibres of guns for many different purposes, and an enormous number of projectiles with all the complications of fuzes and other accesso-

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ries, that in the introduction of a system of rifling, it was only reasonable to expect to encounter sacrifices and unexpected difficulties, such as did occur in the case of the small arms. I will proceed to give the Committee the best information that I can on the subject of those defects and failures, and will speak at the same time of the probability of avoiding them for the future. The first subject I shall refer to is that of the large quantity of ammunition (fuzes more particularly) which is said to be no longer fit for service. This is put down in the return at a value of 45,000 *l.* for fuzes alone; but that sum is the total cost of all the fuzes that have been made up to the present time. A very large proportion of those fuzes have been already issued, and the quantity of them remaining in store is very small indeed. A very large amount of them have been actually used, and expended in practice.

3229. Sir *John Hay.*] And on service?—On service. That sum total embraces all the fuzes that were used in China. This ammunition is treated as obsolete, simply because improved patterns have been subsequently introduced. It is only obsolete in the same sense as nine-tenths of our ships of war are obsolete; but because we have the "Warrior," which is more effective than the "Marlborough," we are not to regard the "Marlborough" as useless. Those fuzes are the very fuzes which rendered such good service in China. They are the fuzes with which the most satisfactory results have been attained at Shoeburyness; but at the same time, the experiments with them suggested improvements which I have not failed to apply as soon as the necessity for them became apparent, and the ultimate result has been the introduction of a more satisfactory pattern. Now the improvements which have been introduced in those fuzes are all of my own suggestion; and I think it can hardly be imputed to me as a fault that I have introduced improvements which have become desirable; until the time when these original fuzes were supplanted by better patterns, they remained the best fuzes that could be obtained. I fear that I shall find it quite impossible to make myself understood on the subject of ammunition unless the Committee will kindly permit me to explain of what the ammunition consisted, and to exhibit specimens of the fuzes in the original pattern, and also in the improved form. In the first place, that is a section of the segment shell, showing the interior construction of the projectile (*producing specimens*). This is the same shell after it has been burst; these being the segments of which I have had occasion to speak so frequently, and which are built up into this fashion, something like bricks in a well. Now, the objection to the original percussion fuze was, that being much longer than the new one, it occupied a much larger space, and prevented the same bursting charge being introduced, so that it was found that the shells divided very imperfectly in consequence of the small bursting charge, and that the segments went away matted together in lumps. Therefore it was thought desirable to increase the quantity of powder, and the only way of doing that was to shorten the fuze. The old fuze had also the disadvantage of being open, so that the damp could get to the interior and moisten the powder and the detonating composition, and the result was the substitution of this new pattern, which is hermetically closed, and which is very much shorter, simpler, and cheaper. I will take this opportunity of explaining to the Committee the principle of construction of this segment shell. The spaces between the segments are entirely closed with lead, which renders the whole interior perfectly compact and solid, so that the interior segments contribute to strengthen the shell, and are like the structure of an arch. In consequence of that I am enabled to have the external case extremely thin, and by that means to get a much larger capacity for those pieces and for the bursting charge than if I were forced to use a thick shell. Now I can only use this very thin shell by such a mode of rifling as mine, and for this reason, that whenever the gun is fired, this soft coated shell is forced into the tightly fitting bore, and the compression of the bore holds it tight and prevents its breaking; without that lateral support I should want a much greater thickness in the external case. I only mention this to show how the projectile may be related to the mode of rifling, so that you cannot alter one part of the system without affecting the other parts. Thus it is with regard to those fuzes. I have found, in my attempts to apply the shunt system of rifling to shells, that even that variation in the mode of rifling (although it embraces the principle of soft metal and compression) necessitated my making certain alterations in the fuzes. These (*producing specimens*) are fuzes for shunt guns, which are slightly different from the others, the alterations being such as are necessitated by the mode of rifling. You cannot ascertain the best method of rifling unless you take into calculation what sort of projectile and what kind of fuze is compatible with that mode of rifling. I produce also the original form of time fuze and the new form. First of all, I found that the material of which the fuze was made was not hard enough to resist the shock; when the gun was fired the violence of that shock disturbed the composition, and caused premature explosion and other defects. In addition to that, this fuze was found to be liable to atmospheric influences, because it could not be perfectly closed; the composition being exposed on the outer edge, an absorbtion of moisture took place, which in time deteriorated the fuze; and, under trying circumstances, such as those of the ammunition that was sent to China, they would all be useless. Another defect was, that the exploding apparatus is in the head and the centre part of the fuze. You will see at once that if this were exposed to any accident which would crush it, it would fire the fuze. Those defects are entirely removed by this new arrangement. These were very great improvements, and it was necessary to introduce them as soon as practicable, and they have been introduced, and the result is that this old form of fuze is no longer the best form; at the same time it does not follow that it is not a usable form. Now in the experiments made at Dublin, the only fault found was that a certain number of shells burst in the guns which were fired a very large number of times. The cause of that bursting was simply this: this new concussion fuze was used in combination with the old, instead of the new time fuze. Now, the old time fuze is not made of sufficiently hard metal, so that the pressure of the old time fuze crushed the top of the new concussion fuze, and exploded the shell.

3230. Sir *Morton Peto.*] I think I understood you to say that the shell in other respects, except the fuze, is the same shell as was used in China?—Exactly; then I should just mention that this change was precipitated by the introduction of the

the 9-pounder shell, which is of the same calibre, but shorter than the 12-pounder, so that we were still more confined for powder space. Also I would mention, that this section of the old concussion fuze (*producing a drawing*) shows much less simplicity than is attained in the new one. Now, while speaking on this subject of fuzes and ammunition, I would observe that I do not think it is right to give the first importance to the mere question of rifling, and to treat the question of ammunition and fuzes as quite secondary; because I can assure the Committee that I have had ten times the difficulty and labour in maturing the fuzes and projectiles that I have found it necessary to expend upon the guns. Even to this day the perfecting of a time fuze for rifled artillery is unquestionably the most difficult problem that is before artillerists. Although I consider the time fuze in its present form perfectly satisfactory with regard to field artillery, it is by no means satisfactory for large guns. I have been working at that fuze for five years, and although the general principle remains the same as it was originally, yet questions of detail have occupied the greater part of my attention for the whole of that time. The adoption of a gun with windage instead of a tight-fitting shot would not at all remove the difficulty. In America and France, where such guns are used, the difficulty is distinctly recognised, and there is no question that they have never yet had a satisfactory time fuze available for rifled guns. Now the reason why this is so exceedingly difficult is this, you cannot recover a time fuze after it has been fired, in a condition to give you any information. Suppose it bursts at the muzzle, or in the wrong place, the fuze is destroyed, or suppose the shell grazes and does not explode at all; when you recover the fuze it is too much damaged for you to discover anything; it is therefore necessary to eliminate by actual experiments every possible cause of failure. Then again the conditions to which a fuze is subjected in a gun are very different from anything that we can imitate. The intense atmospheric pressure which is brought to bear on the nose of the fuze, the effects of the vibratory motion in the gun, and the abruptness of the forward motion derived from the charge are so different from anything we can imitate in laboratory experiments that it is altogether the most difficult subject for investigation I know of. In addition to those fuzes that I have shown you, there is a different set of fuzes for the larger guns (*producing some specimens*); these are called pillar fuzes. In the case of field guns, we require the greatest possible sensibility, whereas, in the case of naval guns, you require a certain amount of resistance to prevent the shell from exploding when it touches the water; and that is an additional element of difficulty.

I think the next matter which I have to refer to, is that of the Shorncliffe guns. Immediately on hearing of those guns going wrong at Shorncliffe, I proceeded with the Inspector of Artillery to examine them, and I made a short report to the War Office, which I will read. "I have examined these guns at Shorncliffe in company with Inspector of Artillery. I will speak first of the guns proper," by that I mean the guns themselves, independent of the vent screws and so on.

3231. Mr. *Vivian.*] Are those the I and K battery guns?—Exactly; "I will speak first of the guns proper, and then of the screws and vent pieces. Ten of these guns are reported to be drawn away from the trunnion hoop, but I find that in nine of these the movement is only a few hundredths of an inch, being merely what is necessary to bring the trunnion hoop home against the supporting ring in front." Now when this was detected it was supposed some very extensive mischief was going on, but it was merely the movement which is unavoidable in shrinking on the trunnion. The trunnion is put on hot, and in that condition is a little longer than when it is cooled; now in shrinking, it leaves a very minute space between those sides and the adjoining hoops, so that it has not to that extent the support of the hoops, therefore, when you begin to fire, if you have the smallest movement of the trunnion, it will slide till it comes up against the hoop in front, and then it remains firm. Now out of 10 guns that were reported to be in a threatening condition, I found that in nine the defect alleged was of this character: that it was this very minute movement, which did not involve the smallest objection whatever to the gun.

3232. *Chairman.*] Can you mention the numbers of those guns?—No, I cannot give you that, but I think there would not be the least question about the numbers. My report then proceeded: "The longitudinal shrinkage in putting the parts together, necessarily causes a little space to be left at this point, and the moving of the trunnion to the extent permitted by this space is no defect at all. The number of defective guns is thus reduced to five, all of which are guns made in the Royal Gun Factory at the commencement of its operation, when the mode of manufacture was imperfectly understood, and the difficulties met with were very great; two out of the five were imperfect from the first, and were repaired by the introduction of thin linings, which as they withstood the proof, were supposed to make the guns as good as any others; but in one of these cases the lining has moved slightly forward, though not sufficiently to disable the gun, and in the other the introduction of the lining has so reduced the thickness of the surrounding coil as to cause it to separate beneath the trunnion hoop, and enable the rear portion of the gun to draw back nearly three-fourths of an inch. In another of these five guns, the defect consists in the development of one of those blisters or hollow places, which, in the early period of the manufacture, were found to constitute the chief trouble and difficulty, but which are now almost entirely avoided. The remaining two guns out of the five have been from the first defective in manufacture or material, and are not such guns as would now be turned out. One of them is not yet unserviceable, but the chase coils have never been properly welded, and are opening at some of the joints. The other is split in the coil, behind the trunnions, apparently from excessive contraction or bad material." That is so far as applies to the guns proper. Then I go on to say:—"The vent pieces which have broken are all of the old steel pattern, already known to be so variable in quality as to cause many failures, but as very few have been found to fail until they have been fired about 200 rounds, and as no damage is done when they do fail, it has been deemed permissible to retain them in use, and replace the broken ones by those of the improved pattern, none of which have ever broken. The breech screws have been found liable, ever since the issue of the 12-pounder field guns, to have the leading

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part of the thread broken off, but as the part which remained always appeared sufficient to bear the shock, the guns have not been recalled for the purpose of being adapted to a stronger form of screw. The explanation of this defect is as follows:—The breech screws are made of steel, and, in conformity with the general opinion that steel was for all purposes much stronger than iron, the thread of the steel screw was made thinner than that of the iron screw into which it fitted. Experience has since shown that steel does not resist concussive action in guns so well as iron; and the steel thread of the breech screw, consequently proves to be too thin. As soon as this fact was ascertained the form and strength of the thread of the screw was corrected, for all other natures of guns, and not a single failure of the improved pattern has ever taken place. The constant practice which goes on at Shoeburyness with 12-pounder field guns, does not appear to show that the liabilities in these Shorncliffe guns prevail to any great extent, but it is desirable that the returns of the annual practice should be obtained as quickly as possible from all the batteries, to judge how far the Shorncliffe case is exceptional."

3233. *Chairman.*] The cases of Shorncliffe, Portsmouth, and Dublin were the only three cases in which there has been continuous firing, were they not?—I cannot say that. The batteries are supplied with a certain amount of ammunition for practice, and, I presume, it is part of their duty to fire a certain portion rapidly as well as deliberately.

3234. Are you aware of any other case in which there has been constant rapid firing for a considerable number of rounds?—Yes, certainly.

3235. Sir *John Hay.*] But those are the only ones reported on specially as failures?—Yes. "Both the 12-pounder sea-service gun and the 9-pounder horse artillery gun, are provided with the improved breech screw and the improved vent piece. The sea-service 12-pounder has too much preponderance for convenient use on a field carriage; but there is nothing to prevent a battery of 9-pounders being tried as severely as possible, in order to establish their efficiency in every point of view, and especially in reference to their screws and vent pieces; I therefore beg leave to recommend that six of these guns be taken indiscriminately and given to a battery for continual practice, until they are pronounced perfectly satisfactory. There will then be no difficulty in assimilating the existing 12-pounder guns in their screws and vent pieces to these 9-pounders. If the preponderance be not objected to, the battery might also be armed with 12-pounder sea-service guns, and tried in a similar manner. Under any circumstances, I think that all guns which have had imperfect barrels repaired by the introduction of thin linings, should be recalled, and have the inner tube or barrel entirely renewed." That is signed by me, and dated the 25th August 1862.

3236. Sir *Morton Peto.*] You said that there were five of those guns defective; what was the whole number?—This was out of a battery of 12.

3237. There were five imperfect out of the two batteries of 12?—There were many more guns at Shorncliffe besides these; but the whole of this occurred in two batteries, each battery consisting of six guns; they were all specimens of the very earliest guns that were made. Now, upon this Minute, and partly no doubt from every one seeing the necessity of determining how far this liability did exist, in other 12-pounders it was ordered that two batteries of guns should be fired rapidly at Southsea and also in Dublin. At Southsea (or Portsmouth) there were 12 guns ordered to be fired, and each gun was fired 123 rounds as rapidly as possible, and the time that was occupied in firing those 1,400 odd rounds, was 138 minutes, including 30 minutes delay, of 14 minutes and 16 minutes each, to clear the range. Now those guns that were fired at Portsmouth were guns with the old form of breech-screw and vent piece, and the old ammunition. The object of that experiment was, to ascertain whether taking the guns as they were with their defects, and the ammunition as it was with all its defects, any serious casualty or difficulty would happen in that amount of firing.

3238. *Chairman.*] But were not those guns specially selected at Woolwich. I think it is stated that the guns were changed, and then that there were others specially selected by the Inspector of Artillery for that experiment?—I am not aware that it was so.

3239. *Chairman* (to General St. George).] Is it the fact that those guns were specially selected?—We went and found them there, but I was under the impression they were selected, and that there was an error in the selection.

3240. Did the Inspector of Artillery select lined guns?—Perhaps I may correct my previous answer. There were only four selected, and the other eight came up in the batteries.

3241. Sir *John Hay.*] What was the object of selecting those guns?—The Inspector of Artillery will probably be able to answer that question.

Colonel *Henry Francis Strange.* — They were supposed not to be lined guns.

3242. But they were lined guns were they not?—One is said to be lined.

3243. *Chairman.*] But why were those guns selected?—They were selected to replace four which were considered objectionable.

3244. *Chairman* (to Sir William Armstrong).] Will you be kind enough to proceed with your statement?—The Dublin experiments took place with everything of the improved form. Those experiments were confined to the later guns with improved vent pieces and improved screws, and the result was, that two batteries of 9-pounder guns fired 100 rounds per gun; one battery in 92½ minutes, and the other battery in 104 minutes; that is to say, 1,200 rounds in about 100 minutes; that was including the time occupied in moving the batteries six times, and in putting up the targets twice, and on one occasion 17 consecutive rounds were fired in 8½ minutes. Now all that was done without the smallest accident or casualty of any kind whatever. I have already explained that some of the shells burst in the guns and slightly defaced the rifling, but did not in the least degree affect the efficiency of the gun, and that accident arose entirely from the fact of improperly using the improved concussion fuze in combination with the old time fuze. It may be, perhaps, satisfactory to know what rate of firing is adequate to the requirements of the service. I may state that I have ascertained that at the battle of the Alma the whole number of rounds fired by the English artillery was only 880, and at Balaclava 840; so that you had fired at Dublin, in the short space of 104 minutes, including all those stoppages, half as many rounds

again as you had at each of these battles, without the smallest difficulty arising of any kind. Now, at Southsea, at all events, eight out of the twelve guns were guns of the battery (and with respect to the other four guns, I do not see that there was any advantage attained by their selection); 1,476 rounds were fired in 138 minutes, and the only casualty was the breaking of one of the old steel vent pieces, and the breaking of this vent piece raised a burr in the gun which required the touch of a file to remove it, and the gun was for a time withdrawn. That experiment was under all the disadvantages of the old patterns and the old fuzes. Then, again, in your Appendix 11, at page 4, there are given the particulars of a 9-pounder which fired 80 rounds in 69 minutes, the first 40 rounds in 31 minutes, and the second 40 in 38 minutes. At Appendix 28, page 44, you have it in evidence that a 40-pounder fired 100 rounds in 85 minutes. In Appendix 14, page 1, you have it in evidence that a 12-pounder, 20-pounder, 40-pounder, and 110-pounder were all fired 50 rounds as quick as possible. At Appendix 12, page 3, you have it in evidence that 50 rounds were fired from a 70-pounder wedge-gun in 32½ minutes, and from a 40-pounder wedge-gun in 31 minutes, and 50 rounds from a 110-pounder wedge-gun in 21 minutes, which is the most rapid firing that has ever been accomplished with a heavy gun. On the subject of vent pieces and screws, I may state that my original guns were made with vent pieces and screws made of steel, and as they had stood perfectly well, I was naturally led to adopt the same material for all the other guns when they came to be manufactured in quantities. It often happens, however, that experience on a large scale developes defects which experience on a small scale failed to bring to light, and that was the case in the present instance. We found that the steel, which had, as it happened, proved of good quality for the first guns, was when it was procured in large quantities (from its very variable quality) in many instances a defective material, and whenever that occurred, we had failures of the vent-pieces. The only alternative was, of course, as soon as that was brought to light to adopt wrought iron, and I believe that in the case of the 12-pounders there has not been a single instance out of very many thousands of rounds fired of wrought iron vent pieces failing. At all events, I am quite certain of this, that in the most improved patterns there is no instance of failure in guns of this calibre.

3246. *Chairman.*] Will you state, for the information of the Committee, when the new pattern was introduced (the one that has not failed), and also the date of all the patterns, the first steel pattern, and so on?—I will put in a return of these dates. Then I must also state that when those 12-pounders were made there was no sealed pattern. The urgency of the demand did not permit of the delay necessary to perfect the pattern before the guns were manufactured.

3247. Is there any sealed pattern now?—Yes.

3248. Is not that sealed pattern a lined gun?—I cannot say. If it is so I am not aware of it.

3249. Captain *Jervis.*] First of all there is an approved drawing sealed, by which the pattern is to be constructed, is there not?—There is not a sealed drawing in the case of the 12-pounder. The drawings are submitted for general approval; but it is not the practice to seal the drawings.

3250. *Chairman.*] But neither is there a specification for the sealed pattern, is there?—I do not think a specification is necessary beyond the drawings. The drawings and pattern together define all the parts sufficiently.

3251. Then there is a sealed pattern, which is a lined gun without any specification, is there not?—I am not aware of that; it is without my knowledge if it is so.

3252. Captain *Jervis.*] Are you aware that the drawing did not represent a lined gun?—Certainly not.

2253. Could you put in the original drawing according to which that gun was to be constructed?—I dare say I could. The original drawing never contemplated a lining; but at the same time, the introduction of the lining was with my perfect approval. I have no hesitation in saying that I was made aware of the lining system being adopted. Mr. Anderson proposed it in the first instance, and I approved of it, because when the gun was subjected to the usual proof it stood perfectly well, and at that time we were under the delusion, if it is to be called a delusion, that a gun which stood proof was safe. I would also observe that although some of these lined guns have failed, yet a great number of them have borne a very large amount of firing indeed. I have memoranda before me of lined gun No. 282, it has been fired 1,176 rounds, and is now in use and as good as ever. No. 98, another lined gun, has been fired 1,276 rounds, and is as good as ever. I might go on to mention No. 44, which has been fired 972 rounds; No. 324, which has been fired 1,145 rounds; No. 192, which has been fired 688 rounds; and No. 337, which has been fired 954 rounds; being six 12-pounder guns, giving an average of 1035 rounds, which are perfectly serviceable. Therefore the lining system was by no means a universal failure. I quite admit, however, after the experience we have had upon this subject, that it was a mistake. It was a mistake also for which I am responsible, though it was not a reprehensible mistake. It was a mistake which I fell into after taking the precaution of proving the guns in the ordinary way, and I should also say that it was done under the very great pressure that existed at that time to complete the guns. We did not at that period re-tube guns, and to have remade them would have caused great delay. It should also be borne in mind that it was not a question of contract. These guns were made in the Royal Arsenal, and I had no inducement whatever to do otherwise than consult the public interests, my object being to save the expense of condemning the guns, and also to accelerate the completion of a certain number of them. I have also a statement of the number of rounds fired from certain unlined guns of an early state of manufacture. I find here, No. 7 has been fired 3,263 rounds, and is perfectly good and serviceable. I have here another 12-pounder, No. 6, which has been fired 1,953 rounds, another which has been fired 1,515 rounds, another which has been fired 1,911 rounds, and another which has been fired 1,146 rounds, giving an average of nearly 2,000 rounds without injury to the gun.

3254. Sir *Frederic Smith.*] Are those selected guns?—No, they are guns in the ordinary course of use.

3255. *Chairman.*] Have the vent pieces been renewed?—Yes, they have been renewed in many cases. In fact it is found that steel vent

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pieces will not bear more on the average than about 200 rounds. Sometimes we get a very good tough one which lasts longer, but that is seldom. Whenever wrought iron is substituted, then the vent piece of the 12-pounder is quite permanent.

3256. Sir *Frederic Smith.*] Can you inform me what number of improvements you have from the beginning up to the present time made in the vent pieces of the 12-pounders, or what number of changes you made which have resulted in improvement?—I began with steel. I then substituted wrought iron, and in combination with that substitution, I proposed that the vent piece should have a projection on the back to fit into the hollow of the screw. The only other alteration that I remember is the affixing of a moveable handle to the vent piece, to prevent the heating of the vent piece interfering with its being manipulated.

3257. And you believe that every change you have introduced has been an improvement?—I have no doubt of it.

3258. Have you now quite given up in despair the idea of introducing further improvements?—I see no necessity for further improvements with respect to the vent pieces of the 12-pounder.

3259. You think their endurance is now sufficiently great?—Quite.

3260. Mr. *Laird.*] How long have the last vent pieces, those which you consider perfect, been tried?—I should think, in the sea-service guns, they must have been in use for about a year.

3261. And on land?—On land not so long in extensive use, because they have only been introduced as the others have failed. Now, then, with respect to the 40-pounder vent pieces, a large number of steel vent pieces were made for the 40-pounder guns before any suspicion arose as to the inadequacy of steel. When the vent pieces began to fail, it was necessary immediately to replace them with wrought iron vent pieces; and that had to be done without the necessary time being allowed for the investigation of the question what kind of iron was most suitable for the purpose. I had not contemplated before that using iron. I had no alternative but to use ordinary good forged iron, and that was found, although much better than steel, to be inadequate. Several 40-pounder wrought iron vent pieces made of that material having broken like the steel ones, I lost no time in making experiments with different kinds of iron. I tried Swedish iron of the first quality without satisfactory results; and it was not until after some time that I ascertained that a kind of Swedish iron, which bears a lower price in the market, and is used for making wire, is the most favourable iron for my purpose. I then adopted that iron, and at the same time slightly thickened the vent piece, and since that time no failure with the 40-pounder vent piece has occurred; so that I now feel quite assured that up to and including the 40-pounder, we are entirely free from the vent piece difficulty.

3262. *Chairman.*] Will you also state the date of the introduction of that vent piece?—I will hand in a return. (*Vide* Appendix.)

3263. And the number of rounds that have been continuously fired with it?—I will. Now with regard to the 100-pounder gun, the difficulty was still greater. I was at first in hopes that the same material which had been used and found sufficient for the 40-pounder would be found equally suitable for the 100-pounder, but that turns out not to be the case. The vent piece for the 100-pounder continues still to be a difficulty. I trust that it will be overcome, but up to the present time we have not obtained a vent piece that can be relied upon for the 100-pounder gun. In the new breech-loading arrangement the block which supplies the place of the vent piece, admits of being very much thicker and heavier, and affords the necessary strength without difficulty. I do not think that there is any reason whatever to apprehend any similar failure in this form of gun; the difficulty in the 100-pounder is, that it is necessary to keep down the weight of the vent piece in order to make it capable of being lifted, but in the new gun, where, instead of lifting the part, it is merely a matter of sliding, the objection to the weight is removed.

3264. Major *O'Reilly.*] Is that slide arrangement yet approved?—Yes; it has been approved, subject to continued firing; but it is not yet introduced into the service. The reports of the experiments with it at Shoeburyness are perfectly satisfactory, but the reports from the "Excellent" are not. The difficulties, however, are of the most remediable character, and just such as are constantly met with in first trials of the kind.

3265. *Chairman.*] Do you consider that you have now got over the difficulty which you referred to in your Report of 1855, namely, not being able "to apply the principle of loading at the breech, except to guns of small dimensions, because in heavy ordnance the moveable parts would become too cumbrous to be conveniently handled"?—Yes, I think so.

Now, on the subject of the general safety of the Armstrong gun, so much prominence has been given to instances of vent pieces breaking and blowing out, that an impression has been created that the gun is a dangerous weapon; I shall, therefore, be very glad if the Committee will satisfy themselves upon that point, and I believe they will find that during the period for which these guns have been in use, namely, five years, throughout which time there has been an enormous amount of practice carried on with them, there has not been, so far as practice on shore is concerned, a single instance of anyone sustaining personal injury of any kind. During that period, many fatal accidents have occurred with the old smooth-bored gun, and if you go back twenty years before that, you will find that although the amount of practice during that time was very limited, yet there were 23 very bad accidents with the smooth-bored guns during those twenty years, independently of the bursting of the guns. Now, I set against that the fact that there has not been, to my knowledge, up to the present time, any instance of personal injury being received by any man engaged in the working of these guns. At sea, accidents with guns are well known to be very much more frequent than on shore, and the number of accidents with the smooth-bored guns during the last twenty years at sea, has been very great indeed. The only tangible case of injury that I have heard of with the Armstrong gun, is that which has been related to you as having happened in New Zealand, the case in which a man lost an eye. I believe that is the greatest amount of damage, either at sea or on land, in connexion with

with those guns. It must be also borne in mind that this period embraces the introductory stage of the history of the gun when the liability to accident is very much greater than it is afterwards, when greater experience has been obtained. The Committee will also bear in mind the results in the actual campaign in China, during which 4,000 rounds were fired with the guns, and I think, therefore, there is no reason for regarding the gun as anything but a highly safe weapon. Now, on the subject of the stripping of the lead from the projectile, this is a matter on which great exaggeration and delusion prevail. In the first place, pieces of the wad are continually being mistaken for pieces of lead; secondly, the projectiles that are recovered after being fired are generally denuded of the lead, in consequence of striking the ground. Persons seeing them in that condition very naturally imagine that the denudation of the covering has arisen from the firing of the gun, whereas, it really does arise from striking the ground. Now, experiments, on more than one occasion, have been made by firing lead-coated projectiles through a small hole in a screen in such a way that the screen should stop all the pieces of lead that might become detached. The other day, 70 100-pounder shells, which had actually been condemned on account of the lead being loose, and which had been returned from ships for that reason, were fired in the way I have pointed out for the purpose of determining whether the lead even in that state would come off, and the result was, that out of 70 shells comprising 5 or 6 cwt. of lead, only 3 or 4 ozs. of the lead was detached and lodged in the target. The same thing has been done with 12-pounder projectiles, and in that instance the only lead which lodged in the target was not lead that had separated itself, but lead that had been actually fused; some small pieces of about the size of a shot being detained in the screen. The original mode of attaching the lead is shown in the drawing which is before the Committee, in which drawing will be seen the lead as attached by common tin solder. Afterwards Colonel Boxer introduced zinc solder, which was found to be perfectly secure. A further improvement was made by myself, in which the grooves which I now point out were retained, but were under cut. I distinctly state that wherever the lead is attached in either of these two ways, the projectiles are perfectly exempt from the liability to have the lead stripped off.

3266. *Chairman.*] What projectiles were those that were used in Major Hay's brigade?—Those were the original old pattern projectiles, in which the tin solder was used, but Colonel Barry distinctly states that even with that pattern, he, on one occasion fired over the wing of, I think, the 60th Rifles for many hours without any casualty arising.

Now upon the subject which has been so often dwelt upon, namely, the complexity of breech-loading guns, I would observe that I quite concur in the opinion, that simplicity is desirable, but I deprecate a change in favour of simplicity at the expense of efficiency, and I am confident that the Armstrong guns in their present form, up to and including 40-pounder, are subject to very few liabilities to derangement, and possess the very highest efficiency for the purposes for which they are made; and this is the opinion of all those officers who have had the greatest amount of experience with them. I think we should be very guarded in making a change after arriving at these satisfactory results, from which if we depart, we do not know what fresh difficulties may await us. I do not at all commit myself to a slavish adherence to what I have already done. On the contrary, whenever I see my way to improvements which may introduce greater simplicity, I shall be anxious to adopt them. I will also mention here, that my shunt gun continues to receive my very best attention, and when I have succeeded in perfecting fuzes and shells for that shunt gun (for that is the sole question with me, and I mention that again as showing how necessary it is to consider the subject of ammunition in connexion with the subject of a gun), I shall submit it to the authorities without having any decided opinion, either in favour of the breech-loader or the muzzle-loader, both of which have their advantages. My object will be to produce a gun on both principles in the most satisfactory form, and I must then leave it to the service to make choice between them. In conclusion, I would beg to reiterate what I think to be the advantages which the country has gained by the expenditure on improved ordnance since 1858. First: I consider it has gained a system of construction for guns which is adequate to the excessive requirements of the present day. Secondly: I consider that it secured by these guns the most efficient aid in bringing the war in China to a speedy termination. That I know to have been Sir Hope Grant's deliberate opinion, and I have heard the same opinion over and over again expressed by officers who were present in the campaign. Thirdly, I think the country has gained a system of guns and ammunition, which, taken in combination, is at present unrivalled. If a rival there be, I, at least, do not know where it is to be found.

Lunæ, 1° *die Junii*, 1863.

MEMBERS PRESENT

Mr. Baring.	Mr. Laird.
Mr. Beecroft.	Mr. Monsell.
Lord Robert Cecil.	General Peel.
Marquis of Hartington.	Major O'Reilly.
Sir John Hay.	Mr. Vivian.
Captain Jervis.	

THE RIGHT HON. WILLIAM MONSELL, IN THE CHAIR.

CAPTAIN RICHARD STRODE HEWLETT, R.N., C.B., called in; and Examined.

Capt. *R. S. Hewlett*, R.N., C.B.

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3267. *Chairman.*] YOU are Captain of Her Majesty's ship "Excellent"?—Yes.

3268. That is a ship for gunnery practice, I believe?—Yes, it is a ship for gunnery practice.

3269. How long have you been Captain of the "Excellent"?—Six years.

3270. What guns have specially been brought under your notice during that time, speaking of rifled guns?—Armstrong guns, principally.

3271. Have any other guns been brought under your notice?—I have had practice with the Whitworth guns also.

3272. Will you, in the first instance, state to the Committee the general impression you have derived from your practice with Sir William Armstrong's guns, beginning with the 12-pounders, and going through the different calibres?—I have had considerable practice with all natures of Armstrong guns, 12-pounders, 20-pounders, 40-pounders, and 110-pounders, firing many thousand of rounds at different times. I have a very high opinion of them with respect to range, accuracy, and perfect safety, with common care. They are subject to little defects, and liabilities to derangements and accidents, but not if proper care is taken with them.

3273. Do you mean by proper care, such care as could be taken in action?—I think, possibly, in the excitement of action they might neglect to screw up the vent-pieces, and that is the principal cause of accident; therefore, I consider that they are a gun that should be used only a few of them in ships for long ranges, for special purposes, and slow, steady firing.

3274. Do you approve of the proportion that our ships are now armed with?—Yes; I think it very good, and assisted in making it out.

3275. Will you state to the Committee what it is, exactly?—The proportion in large ships is that the whole upper deck is armed with Armstrong guns for long range and bombarding, and three or four guns on the 'tween decks, for the purpose of firing ahead or astern, chase guns, as they are called; all the others I consider should be smooth-bores. I think the smooth-bore, as the general arm, should not be disturbed; they possess many advantages which rifled guns do not. You can fire from them with double shots, shot and shell, red hot shot, and many other things; and also you have the advantage of ricochet firing. Rifled shot generally turn to the right on striking the water, and rise at a very high angle, and go several hundred yards before they fall again, so that unless you strike direct, the chances are that it is a lost shot.

3276. Now, are the objections that you make to the Armstrong gun, objections to any sort of rifled gun, or are they objections that peculiarly belong to the breech-loaders?—Not altogether; some of them apply to all rifled guns; for instance, the loss of ricochet firing affects all rifled guns, but, no doubt, from other guns, and, perhaps, from the Whitworth gun; if it was a muzzle-loader, you might fire common spherical shot and shell, and even red hot shot and liquid iron.

3277. But taking the objection that seems most generally felt to the Armstrong gun, its complication, would that apply to a muzzle-loader rifled gun?—No, it would not apply to the muzzle-loader; but the breech-loader gun has a very great advantage in many ways over the muzzle-loader.

3278. Will you state those advantages?—They are more easily worked, with less labour to the men and greater safety to the men; no sponging is required, and you can use the long guns in narrow-waisted vessels, and in some cases in working lee guns you have a very great advantage in time.

3279. The firing is more rapid?—Yes, the loading is more rapid; in the muzzle-loader you have to run the gun in to load, and in the other case you load the gun out, or in whatever position the gun is.

3280. I think that one of the objections stated to the Armstrong gun by Lord Lauderdale and others, is the inaccuracy on board ship on account of the slowness of the peculiar sort of powder used; do you concur in that?—I have never found it so; the accuracy is very great; the shot goes in a straight line.

3281. Captain *Jervis.*] For the Armstrong gun is there a different sort of powder?—Yes, a slower burning powder.

3282. *Chairman.*] And there being that slower burning powder, as I understood Lord Lauderdale and other witnesses, they said that the motion of the ship caused it to be more difficult to take a correct aim; you have not observed that?—No, but it possibly may make a difference as to the proper moment for pulling the trigger line.

3283. Your

3283. Your practice has been in smooth water, I suppose?—No, we practise a great deal from the gun-boat outside; but so much depends on the distance being accurately known, that no good practice can be made without it.

3284. We have heard a good deal with respect to repeated accidents to vent-pieces, have you had any experience of the new vent-pieces to which Sir William Armstrong referred in his evidence that he gave the other day, vent-pieces made of the Swedish iron that bell-wires are made of?—I do not know it by that description; we have just tried one called Mushett's steel; that is not the same.

3285. You have nothing but the common steel and wrought iron on board?—No.

3286. What was the result with the Mushett steel?—It is going——[Sir *William Armstrong.* It is not a composition of mine.]

3287. *Chairman.*] So far as your experience goes on board the "Excellent," the difficulty with respect to the vent-pieces, has not been got over?—The difficulty is so far got over that the vent-pieces are very much improved by a projection placed in the rear, which prevents them blowing out in case of accident. I think we have had six or seven in the whole of our practice that have cracked, but not more than that.

3288. Out of how many rounds?—Perhaps 7,000 or 8,000 rounds.

3289. Then how do you account for the fact that different officers who have fired a very small number of rounds have found so many broken?—It is a very curious circumstance, but quite unaccountable.

3290. May it arise from your having very skilled men on board the "Excellent" who are very much accustomed to the gun?—No; I do not think that is the case. They had our own men in the trial on board the "Trusty," at Sheerness, when 13 or 14 went one after the other.

3291. But still on board the "Excellent" they do not go at all in the same proportion that they have done in other places?—No, they do not; we have been most fortunate in that respect.

3292. Another matter is the liability to flaws, have you taken any notice of the effect of flaws upon the Armstrong gun?—Yes; at first we had two or three guns that had what were considered rather bad flaws in them, and the guns were exchanged, but I believe the flaws were perfectly harmless; in fact, we burst on one occasion four shells, which tore the rifling very much; we had men down from Woolwich, who removed them, and we have fired hundreds of rounds from that gun since.

3293. Sir *John Hay.*] You broke those shells intentionally, did you?—No, it was accidental in trying experiments.

3294. *Chairman.*] What is your opinion of the fuzes now used with the Armstrong gun?—The pillar percussion fuze answers well, but the time fuzes are still unsatisfactory.

3295. Is the pillar fuze a new one?—It has been introduced some time; it is a percussion fuze. But the one I refer to as being in an unsatisfactory state is the time fuze.

3296. Except the pillar fuze, do I understand you to say that the fuzes are not in a satisfactory state?—The time fuzes are not yet in a satisfactory state.

3297. Have you had any experience to enable you to judge with respect to the way in which the lead coating adheres to the rest of the projectile?—In our first trials we found that portions of the lead stripped off in the projectile whilst passing through the bore, but now for a long time we have very rarely observed that.

3298. Have you seen that at all with the new system of coating introduced by Colonel Boxer?—No, I think not; but we are still using the old projectiles.

3299. Have any accidents happened on board the "Excellent," or within your observation?—Yes, four or five vent-pieces have blown out.

3300. Have any serious results followed?—Nothing more than destruction to the cabins and scorching some of the men; but nothing serious.

3301. Captain *Jervis.*] You have had more experience than any naval officer with respect to the different natures of rifled guns, have you not?—Simply those of Sir William Armstrong and Mr. Whitworth; but of course the naval officer attached to the Ordnance Select Committee has had more experience of a variety of guns than I have.

3302. But you have tried almost more experiments on board the "Excellent" with those guns than any other naval officer, have you not?—With those guns of Sir William Armstrong; but not much with Mr. Whitworth's.

3303. Have you observed, during the last six years, that there has been a very great improvement in the Armstrong gun?—No, I do not think so; I think we commenced under very favourable circumstances; there have been improvements in the gear belonging to the gun, but not in the gun itself.

3304. In what year did you have the first 40-pounder?—I think it must have been about 1859 or 1860.

3305. And it was then given you as perfect as it is now in every way, was it?—Yes, I think so, as regards the gun.

3306. In what year did you have the first 110-pounder?—About the same time, I think.

3307. Have you got many faults to find with them?—None whatever. I have a very high opinion of them. I am sure that if you only took care to screw the vent-pieces up, there is no danger attached to them. I feel as safe standing behind them when firing as I do sitting in this chair.

3308. Have you had any other guns brought to your notice which you think would be preferable for the general service?—Not for general service as a rifled gun, certainly; perhaps for penetrating plates the Whitworth gun has done more than any other gun yet; it penetrates a 5-inch plate at 800 yards.

3309. Would you not, therefore, prefer having it on board ship for a rifled gun?—For that special purpose I would; but first, there is the question of safety, and whether you can continue loading it after a few rounds without the shot jamming in the bore.

3310. How many rounds did you fire with it?—We never fired very many; our experience with the old Whitworth 80-pounder was that the shot jammed in the bore; but since that the windage has been increased.

3311. But that has not been brought to your notice?—No, it has not been tried in the "Excellent."

3312. Major *O'Reilly.*] Will you state generally, what your impression was of the Whitworth gun?—My impression of the Whitworth was, that

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that it had a very great range and great accuracy, but I never considered it a safe gun.

3313. For what reason?—I have seen a trial with another gun with an iron projectile, working against an iron bore, and it has burst. Major Cavalli, a Sardinian officer, brought it over here, and I believe no gun will ever stand iron working against iron, and with so severe a twist as the Whitworth gun has.

3314. Do you think it tends to bursting?—To bursting; we burst one on board the "Stork"; that was a cast-iron gun.

3315. That would not be a fair test?—No; after that we had a wrought-iron 80-pounder, and that split.

3316. When the shot jammed was the gun sponged?—It was always sponged; but the difficulty is, to get the sponge into the rifling.

3317. But there is no difficulty in the polygonal bore, is there?—Yes, I think so; great difficulty.

3318. Do you think that the breech-loader is, on the whole, better than the muzzle-loader?—It has many advantages; but if you could get a good safe muzzle-loader, the projectile going home with ease after a continuous fire, and if it was a safe gun, I think, possibly, I should prefer the muzzle-loader.

3319. Have you tried Sir William Armstrong's shunt muzzle-loader gun?—I have seen it fired.

3320. How far did you consider it successful as a muzzle-loader gun?—I consider that is the true principle; it has a compound shot, which comes out on bearings of zinc; then if anything happens the zinc strips, the shot escapes, and the gun is saved.

3321. For that system of gun you necessarily must have a new system of fuzes; the fuze cannot be fired by the explosion of the powder, is not that so?—I consider that the common fuze for the smooth-bores will answer for the shells of all muzzle-loading guns.

3322. Or in any system of coated shot?—The common time-fuze for spherical shell will answer for muzzle-loading rifled projectiles as well.

3323. There is sufficient windage, is there?—There is sufficient windage.

3324. In action do you think the present breech-loader liable to get out of order?—No, not at all; the vent-pieces may crack, but we have three spare ones to each gun.

3325. Were you present at the experiments on board the "Trusty"?—No, not when the cupola was fired at.

3326. It is said that one of the vent-pieces cracked and got jammed in the gun, and was not got out until the following day; that would permanently disable the gun, would it not?—Yes; but that is a solitary instance of the kind.

3327. I think there is a second instance in Admiral Dacre's evidence; he says that a vent-piece broke on board the "Chanticleer," which it took two days to get out; that would have disabled the gun for that action?—No doubt of it.

3328. And there is evidence given of three or four vent-pieces being blown out at night quarters?—I think that would very likely happen from not screwing the vent-piece up; possibly not seeing the marks.

3329. Clearly all these accidents happen from not screwing up the vent-pieces, and the question then is, how far you think it likely they would not be screwed up at night quarters or in action?—I think it very likely.

3330. Mr. *Beecroft.*] I understood you to say that Sir William Armstrong's guns were best adapted for slow and steady firing?—Yes.

3331. Are we to understand that you think Sir William Armstrong's guns too complicated for use in general action?—Not at all; I consider them very simple; the only thing is that in the hurry of working the guns in action they might not screw up the vent-pieces.

3332. You think that they are well adapted for use in general action?—I think so, in careful hands, and if they are ordered not to be too rapid in the firing, and to take care to see the vent-pieces screwed up properly.

3333. Would you prefer Sir William Armstrong's rifled breech-loader, or Mr. Whitworth's muzzle-loader for use in general action?—For general purposes in action, a breech-loader possesses many advantages; but I think I should prefer a muzzle-loader if a safe gun could be got, and if there was no doubt of its loading easily after much continuous firing.

3334. Does not the smoke rather interfere with the breech-loader?—Not more than the muzzle-loader; there is nothing comes out of the breech.

3335. Mr. *Baring.*] You would prefer, on the whole, a muzzle-loader to a breech-loader, if you could get one?—Yes.

3336. Have you seen a muzzle-loader that you would recommend as being perfectly adapted for the service?—No.

3337. The objection of the mechanical fit with respect to the loading and wearing of the gun, has not been surmounted?—No; I think it certainly has not; projectiles go in very easily at first, they slip in almost; but after firing 20 or 30 rounds, you find that a hard deposit forms in the rifling, and the shot jams.

3338. On the whole, you consider the right principle is, that the shot should bear the strain, and not the gun?—Just so.

3339. That principle is adopted in the shunt muzzle-loader gun, is it not?—It is adopted in the shunt muzzle-loader gun.

3340. Have you any means of comparing the accidents that have taken place with the Armstrong breech-loaders, with the accidents that have taken place in the course of firing of the same duration, with the ordinary 68-pounders, in respect to injury to persons concerned in the loading?—We never had any injury with the 68-pounders.

3341. Not in action, or in the service generally?—No.

3342. And not in practice in the course of years?—Never; we rarely have a gun burst; it is a very rare case indeed. I have been a gunnery officer 30 or 40 years, and I have never seen a gun burst excepting the Whitworth rifled ones.

3343. Does the gun never explode prematurely in action, or in firing for practice?—No, never, that I have witnessed.

3344. Do you recollect whether the 80-pounder Whitworth breech-loader was tried on board the "Excellent?"—Yes.

3345. What date was that?—That was the gun that burst in 1861; it split, rather than burst.

3346. What was your opinion of that gun?—I did not like the breech-loading arrangement at all; I thought it was very faulty.

3347. When

3347. When was the next Whitworth gun constructed by Mr. Whitworth, tried on board the "Excellent"?—No other Whitworth gun has since been tried on board the "Excellent."

3348. Was that a 70-pounder?—No, an 80-pounder.

3349. Was that one of the guns that were constructed at Woolwich; was it wrought-iron, or homogeneous metal?—It was homogeneous metal.

3350. The whole of the gun?—The whole of the gun; I think it was called a homogeneous gun, but I will not be positive.

3351. You only had it for a short time?—That is all.

3352. When was an Armstrong gun first put into your hands to practise with?—Four or five years since, when the Armstrong guns first came out; we had a 30-pounder gun first; the first that was ever tried; it was first tried at Woolwich, and then at Shoeburyness, and then it was sent to us.

3353. Do you consider that the expenditure that has been incurred in the introduction of the Armstrong gun into the service has been usefully incurred with respect to the armament of the navy?—Yes, certainly, I think it one of the best rifled guns for general service that we know of.

3354. And looking back and knowing all the circumstances of the case, and being aware of the different guns that have been suggested since, do you see any reason to suppose that a different course pursued by the successive Governments would have produced a better gun?—I think not.

3355. General *Peel.*] You stated, I think, that the first gun tried by you on board the "Excellent" was a 30-pounder?—Yes, a 30 or a 32-pounder.

3356. Do you recollect what the date of that trial was?—I think 1858 or 1859.

3357. Was it upon your report that the Admiralty adopted the rifled guns for the naval service?—No, I think not; perhaps my report might have had something to do with it; but I think it was the report of the Ordnance Select Committee.

3358. The Ordnance Select Committee confine their recommendation to the adoption of the Armstrong gun for the field service?—I am not aware.

3359. That would appear from the correspondence between you and the Admiralty, which was published in the Appendix of last year. On the 17th January 1859, did you recommend that it was very desirable that the Armstrong guns should be at once introduced for boat service?—Yes, in 1859.

3360. What was the size of those guns that you recommended?—I recommended the 20-pounders and 12-pounders for boat service.

3361. So that it must have been a smaller gun than the 30-pounder that was first submitted to you for trial on board the "Excellent?"—Yes, I see that I recommended these boat guns in 1859; the 30-pounder must have been sent us after that.

3362. The Admiralty are responsible for the introduction of any gun, whatever it may be, into the naval service?—Certainly.

3363. After they have approved of a gun you make a requisition to the War Department, who have to provide it?—Yes.

3364. The War Department are in no way responsible for the guns introduced into the naval service?—Certainly not.

3365. On the 13th July 1859, you say, "I should, therefore, beg to suggest that no unnecessary time should be lost in placing Armstrong 40-pounders on the upper decks of all vessels, substituting them for the present revolving guns?"—Yes.

3366. Therefore, it would appear from this letter that the Admiralty, convinced by your report, had decided upon the introduction into the Naval Service of the Armstrong guns, and had made a requisition to the War Department to supply them?—No doubt.

3367. And therefore the Admiralty would be to a great degree responsible for any expenditure that took place?—Yes; I do not think they wish to avoid that responsibility.

3368. Of course a heavy demand was made on the War Department from the Admiralty, in consequence of their approving those guns?—Yes; there were meetings held at the Admiralty, and they decided on the number of guns that should be demanded from the War Office.

3369. Therefore it was necessary for the War Department to provide for the necessary expenditure, for the purpose of furnishing those guns?—Exactly.

3370. Mr. *Vivian.*] Has your attention been called to the report of this Committee to the House of Commons last year?—No.

3371. At page 176 there appears to have been a meeting of a special Committee on iron plates and guns, and this passage occurs, "The Committee approved of the adoption for the Naval Service of Sir W. Armstrong's 40-pounder of 32 cwt., 10 feet in length, but propose that it be reduced when necessary to a gun of 30 cwt., with a length of 7-feet 6-inches." Now it appears that on the suggestion of that Committee the gun was introduced into the service, and a large number made; are you aware of that fact?—I was not aware of that report before, but I knew they were favourable to the introduction of the gun.

3372. General *Peel.*] This is not the Committee to which I referred?—No.

3373. (To Sir *W. Armstrong*).] Do you know whether the Committee to which the Honourable Member on my left has just referred, was a Committee appointed by the Admiralty?—It was not appointed to determine whether the guns should be introduced; it was to determine the weights, calibres, and so on; the only question was with respect to the weights, calibres, and so on.

3374. *Chairman.*] But the Committee had decided on the part of the Admiralty that the guns should be introduced?—The Admiralty themselves had decided that without any Committee.

3375. To the *Witness.*] Colonel Lefroy was asked before this Committee last year at question 269, "On whose recommendation was the gun adopted into the naval service; was it upon the Report of this Committee?" and he answered "Upon the Report of the Committee that it was a proper gun to be used, and the decision of the Lords of the Admiralty that they wanted such a gun." He was then asked "You do not refer to this special Committee?" to which he replied "No it was long subsequently to that." The question was then asked, "Then did another Committee report upon that gun?" he replied, "The Ordnance Select Committee reported upon it

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it as a naval gun." Then he was asked, "And it was upon their recommendation that it was introduced?" he answered, "I think a decision of the Admiralty was come to, that they would have it before the Committee recommended it. Having the 12-pounder, it was no material change to make a somewhat lighter gun for both services." That I suppose is the true state of the case?—Yes.

3376. Mr. *Vivian.*] How many 100-pounder Armstrong guns have you had under trial in the "Excellent"?---About seven or eight.

3377. And no flaws of a serious character have appeared in those guns?—Flaws that we considered serious exhibited themselves at first, and the guns were returned for repair, but we have since that, found that they were not serious and have gone on firing with them.

3378. With respect to the jamming of the vent-pieces, have you not found the vent-pieces jam?—Sometimes, but rarely, they jam for an instant, but they are immediately relieved by a lever; they are never jammed for any length of time.

3379. In No. 14 of this year's Appendix, page 4, this passage occurs "At the usual inspection" (this is the inspection of the 110-pounder guns mounted at Plymouth citadel) "the vent-pieces stuck, and were so difficult to extract, that practice was abandoned after firing six rounds." Has anything of that kind occurred within your experience?—No, never.

3380. Have you tried the side breech-loader?—We are now trying it.

3381. Do you find it satisfactory?—No, there have been several little defects exhibit themselves, but nothing that cannot be got over; I think it will be a satisfactory gun. I saw 100 rounds fired at Shoeburyness in 60 minutes, and there were no hitches; the same guns were sent down to us, and little disarrangements have occurred which will I think be got over easily.

3382. Have you found that the screws clog at all?—Sometimes there is a little difficulty in screwing the vent-pieces up, but nothing to cause you to cease firing.

3383. In the heat of action would there not be a liability for the vent-piece not to be screwed home?—Not with care, because they have marks; we always take the precaution of chalking the gun, so that they should be screwed home.

3384. Do you imagine that would be adhered to in the heat of action?—You would place careful men at the gun; but I think possibly that it might be neglected, and that is the chief fault of the gun.

3385. Is the handle of the lever of the breech-screw ever broken?—I have never known it break.

3386. Have you found the recoil of the gun excessive?—It is rather more violent than with the smooth-bore, it being a rifled gun, but nothing excessive; we never carry away any breechings.

3387. Are different breechings used with the Armstrong gun from those in common use in the service?—No, just the same.

3388. Do you think that the calibre is well adapted to the weight of the gun?—No, I think the shot is too heavy for the guns generally. I think it must be reduced, more especially with the new 70-pounder. I think the charge is excessive, and in that gun the recoil has been very violent. It is called a 70-pounder, but it is absolutely 80; it has an 80-pounder shot.

3389. Of what calibre is the gun, taking it in inches?—I do not know exactly what it is; about 6½ inches.

3390. Have you found the carriages disabled at any time?—Never.

3391. Have you practised with shell?—Yes.

3392. Have you ever observed the shells to turn over in their flight?—The shot and shell sometimes strip, but very rarely, and then they do turn over.

3393. But without stripping, have you observed them turn over?—No, never; our practice has been most accurate.

3394. We have had it stated in evidence, that 10 out of 12 in some cases turn over, but you have never had anything of that kind?—Never.

3395. You say you prefer that the shot should bear the strain instead of the gun; will you kindly explain that?—By its being a compound shot and being coated with a soft substance, the strain would be on the gun in some degree, but not so great as when the iron is brought against it.

3396. But the tension of the gas is the same inside the gun, I suppose?—Yes.

3397. Consequently, there must be the same strain on the gun?—So far as the gunpowder is concerned, yes; but the projectile, in passing through the bore, being clothed with a soft substance, does not strain the gun so violently as if it were composed of hard metal.

3398. Do you imagine that there is any strain beyond the strain due to the tension of the gas within the gun?—No; except that caused by the twist of the rifling.

3399. Then would not the strain be equal in both cases?—When I speak of the strain on the gun, I mean the projectile coming in contact with it.

3400. You mean the friction?—Yes.

3401. Sir *John Hay.*] The rigid shot jams, and the other has a surface which yields?—Yes.

3402. Mr. *Vivian.*] But what reason have you for supposing that a mechanically-fitting shot jams in the gun; does not the initial velocity test that question?—We find that it does do so; the 68-pounder cast-iron gun of Mr. Whitworth plainly showed in the pieces picked up that the projectile was trying to leave the rifling, and jammed in the bore.

3403. Is not it the case with every rifled gun, that the projectile has a tendency to leave the rifling, whether the projectile is coated with soft metal, or is mechanically fitted?—Yes, just so; but in this case, it succeeded; it did leave the rifling.

3404. But is there any reason to believe that if the shot had been coated with soft lead, and the gun had been cast iron, there would not have been the same tendency to strain the gun?—I believe not.

3405. Then you believe that a cast-iron gun might be safely used as a rifle gun if the projectile were covered with lead?—To a certain degree it would increase the safety of the gun, no doubt.

3406. Has that ever been tried?—I do not know.

3407. That would be a very simple solution of the whole difficulty, would it not?—No, I think not; the question requires great consideration. Mr. Bashley Britten has produced a gun of that kind

kind whose projectile is not coated with lead, but has lead attached to its base, which expands like the Minie projectile in firing.

3408. You derive your belief that there is a greater strain on a gun rifled on the mechanically-fitting principle than on the soft lead principle from the pieces of the Whitworth gun that you picked up?—Yes, from that one gun.

3409. But there is nothing to show that the same thing would not have happened if the shot had been coated with lead, is there?—No, nothing. I, however, saw another gun made by Cavalli, on much the same principle, and that burst.

3410. Was that a wrought-iron, or a cast-iron gun?—It was a cast-iron gun.

3411. Is it fair to compare a cast-iron gun with a wrought-iron gun?—No, not at all.

3412. When the shot jammed in the Whitworth gun, was the gun being used as a muzzle-loader, or as a breech-loader?—As a muzzle-loader.

3413. Was it sponged out in the ordinary way of sponging a muzzle-loader?—It was spunged out in the ordinary way, and in addition water was used.

3414. Have you seen Krüpp's steel guns?—No, not at all.

3415. When you expressed an opinion that no better gun could have been adopted by the Government during the past few years, you did so without any knowledge of Krüpp's system?—I do not know anything of that system. I speak from the practice I have had with the gun, and the results I have obtained from the gun.

3416. *Chairman.*] You said that you thought the amount spent by the Government on the Armstrong gun had been judiciously spent; do you know what the amount is?—No; I suppose it represents millions of money, but we were forced into it at the time by other nations having rifled guns. I believe they were the best guns then, and are now the best guns for general service.

3417. You have already defined what you mean by general service; you think there should be a certain number of guns up to a certain calibre?—Yes.

3418. Sir *John Hay.*] Do you receive official reports from the commanders of ships in commission, of their experiments in gunnery?—Yes; through the Admiralty.

3419. I suppose that you have the opinions of the officers of the Navy generally on the Armstrong gun?—Yes.

3420. What is the general opinion in the Navy?—I think they are rather adverse to the guns; they are rather frightened of them from two or three little accidents; but our men and officers have the most perfect confidence in them; it is only to know the gun, to be perfectly satisfied of its safety, but I think that the feeling in the fleet was rather against the gun; it is being got over now; they fancy it is complicated, but really it is not so.

3421. Is that with respect to the breech-loader, or the rifled system generally?—The breech-loader.

3422. Are there many officers who have reported favourably of the gun?—I do not think they have ever been called upon; at least no general report has been sent to me.

3423. You stated, just now, that the penetration of iron plates by the Whitworth gun had been more successful than the penetration of iron plates by the Armstrong gun; is not that due to the increased charge and velocity, and the small diameter and the steel shot?—Yes.

3424. The same result might be anticipated with a shot of the same character moving at the same velocity from any rifled gun, I suppose?—No doubt.

3425. Might not the Armstrong shunt-gun be used with a spherical shot, and an increased charge and windage?—No doubt.

3426. And then you think that that gun would do away with that difficulty of want of confidence in the breech-loading system?—Yes.

3427. And would be available for both purposes; for rifle practice and mere close action, with a higher charge and a less weight of spherical shot?—Yes.

3428. *Chairman.*] The Armstrong shunt-gun is not the gun on which this large expenditure has been made; it is the breech-loader, is it not?—Yes; the shunt-gun is of much later introduction into the service; indeed, it is now only an experimental system.

3429. Are there only a small number of them made?—Very few; a few for trial, that is all.

3430. Captain *Jervis.*] You said there was a general feeling against the breech-loader Armstrong gun in the Navy, and you spoke about the vent-pieces being blown out, but I believe we have no evidence of any man having been seriously injured by that?—No; one man lost an eye, but I think that is the most serious accident.

3431. In the course of your service you have heard very frequently of men being injured by muzzle-loaders; arms being blown off, and men being blown to pieces altogether?—Yes; the breech-loaders are safer to load than the muzzle-loaders.

3432. As that fact must be so apparent to naval men, is there any reason for this dissatisfaction against the Armstrong gun?—No, nothing but fancy; it is a new thing; they do not understand it perfectly, and a few accidents have occurred which have startled them.

3433. Do you think there has been a desire to induce them to be dissatisfied with the gun?—Not at all; but to be satisfied with it.

3434. Mr. *Baring.*] You have been asked whether the expenditure on Armstrong guns had been made principally on the breech-loader, or the shunt-gun. Does not the peculiarity of Sir William Armstrong's system lie far more in the way in which the gun is built up, than any peculiar sort of rifling, whether it is a muzzle-loader or a breech-loader?—I believe that you cannot use Sir William Armstrong's gun as a muzzle-loader.

3435. But is not the peculiarity of Sir William Armstrong's invention far more in the general construction of the gun, that is to say, in its being built up in coils in order to stand a very large charge of powder rather than in the gun being a breech-loader or a muzzle-loader?—In both.

3436. The construction of the gun is the main part of the invention, is it not?—With respect to its strength and safety, of course it is; but the rifling is a very considerable part of it, and its being a compound shot.

3437. *Chairman.*] Is there anything further which you wish to state to the Committee?—No.

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3438. *Chairman.*] Is there any statement which you wish to make to the Committee before we proceed with your general evidence?—Yes; perhaps the Committee will allow me to clear up a little ambiguity about the fuzes, in reference to what has been stated by Captain Hewlett. The fuzes are partly for land service and partly for sea service; for the land service they consist of concussion fuzes and time fuzes, and for the sea service they consist of the pillar fuze and the time fuze. Now, in so far as the land service fuzes are concerned, I maintain that they are perfectly satisfactory, and no objection is made to them. So far as the sea service fuzes are concerned, with respect to which Captain Hewlett spoke, the pillar fuze is the only one that I consider exists in a matured form; the time fuze is not put forward permanently; the fuze now being used is merely a temporary expedient until a more perfect fuze can be produced.

3439. What were the fuzes used at Portsmouth?—The old pattern concussion and time fuze.

3440. You do not consider those fuzes satisfactory?—I consider them inferior to the new pattern.

3441. You stated with respect to the ammunition termed obsolete by the Committee of Artillery Officers, that they were the fuzes with which the most satisfactory results had been obtained at Shoeburyness, is that the ammunition with which such unsatisfactory results were obtained at Portsmouth?—No; the time fuzes which were used at Portsmouth had been deteriorated by exposure, and those were not satisfactory; but the old pattern fuze, though inferior to the new one, has given very good results in China and at Shoeburyness.

3442. What I want to direct your attention to, is the fact that the same ammunition failed at Portsmouth which succeeded at Shoeburyness; do you not consider it of the greatest possible importance that any ammunition used in the service should be ammunition of a character that would be able to bear storing and not suffer from the effect of being kept?—That is the great advantage which the new pattern has, namely, that it is not susceptible of that deterioration.

3443. Mr. *Baring.*] You mean to say that the experience you had had with the time fuze was not satisfactory, and so you introduced an improvement, avoiding the probability of damage by exposure to the weather?—Exactly.

3444. *Chairman.*] You express great confidence in the new pattern; I think you also say with respect to the vent-piece, that up to the 40-pounders you are perfectly satisfied?—Yes.

3445. Was there not exactly the same confidence expressed with respect to the guns and ammunition before those changes were made; Colonel Bingham stated that up to August or October last he was perfectly satisfied with the gun, and that his eyes were opened by certain experiments which were then tried at Portsmouth and Shorncliffe; was not the same confidence felt in the gun in its former state as that which you now express?—The question is whether I can give good reason for my present confidence. I think I can do so easily.

3446. But what broke down the former confidence was that there were certain trials made with more rapid firing than before, which showed that the former confidence had been misplaced; therefore, I now ask you what experience, to justify your present confidence, there has been with reference to the new vent-pieces in the first place, and then with regard to the fuzes. Take first the 12-pounder gun and then the 40-pounder gun?—My reason for feeling confidence is, that no accident has ever occurred to a vent-piece of the new pattern. I now speak strictly of the 9-pounder and the 12-pounder; in fact, no 12-pounder vent-piece made of wrought-iron has in any instance broken.

3447. What trials have been made of them; where have they been tried; who tried them; and what number of rounds were fired?—They have been tried to a great extent at Shoeburyness; I cannot say definitely what number of rounds, but I can state that we have not lost any at proof, and that in one instance we fired 90 proof rounds with one vent-piece, without injuring it, which is an amount of trial that appears sufficient to give perfect confidence in the vent-pieces.

3448. Would it be possible for you to produce any report showing the number of rounds fired with the new vent-pieces?—No, I think not, because they are so mixed up with the others.

3449. But still I may be permitted to call your attention again to the fact that there was the most unlimited confidence expressed in the old fuzes?—I can hardly be responsible for other people's confidence.

3450. But if you had not had a similar confidence yourself, I suppose, the guns would not have been allowed to become the exclusive armament of the artillery?—Steel was used altogether in the first instance for those vent-pieces, but steel undoubtedly proved untrustworthy, and we had many accidents. That led me to adopt the wrought iron, and with the wrought iron we have had no accidents; upon that fact, I base my present confidence; there has been no accident with those wrought-iron 12-pounder vent-pieces in a very considerable extent of practice, and in one case we fired 90 proof rounds with one vent-piece; and therefore I think we have good ground for confidence.

3451. Will you state to the Committee what your experience has been with respect to the 40-pounders?—I think the fact that no fewer than 1,200 wrought iron vent-pieces have been proved without one single failure, shows that we may place great confidence in the present form and material; there is not a single failure attributable either to the pattern or the material.

3452. Under what circumstances have those trials been made; has there been any rapid firing?—I think there is a great delusion about rapid firing; I am sure that no one can produce any sufficient reason for showing that rapid firing causes an additional strain either upon the gun or the vent-piece.

3453. But as a matter of fact, was it not the rapid firing at Shorncliffe and Portsmouth that changed the opinion of military authorities with respect to the security of the gun?—No, I think not; not at all.

3454. Is not that the impression left upon the mind by that report of Colonel Bingham?—I cannot say; but my own firm conviction is, that rapid

rapid firing has nothing whatever to do with the strain upon the gun.

3455. Then to what do you attribute it that the military authorities had perfect confidence in the gun up to October last, and that suddenly their opinion was changed?—It seems they met with certain defective guns which happened to give way at that period.

3456. Was it on account of any peculiar manner in which they were then fired?—No, I think not at all. There is no expression of opinion in the answers of Colonel Bingham's, with respect to the rapid firing causing an additional strain upon the gun.

3457. Captain *Jervis.*] Nor with respect to dissatisfaction?—No.

3458. *Chairman.*] Will you look to Question 366 in Colonel Bingham's evidence: Colonel Bingham there describes the change that came over his mind with respect to the guns. He says, "my duty constantly took me down to Shoeburyness, and I always considered that it was the most powerful gun, and the best rifled gun that there was; after it was introduced into the service there were a great many small changes made, and up to last autumn, I should say we had perfect confidence in the gun in every way until at the ordinary practice at Shorncliffe six of the guns became very much damaged, in fact, unserviceable. It was in consequence of those guns going wrong that the Commander-in-Chief asked for those 100 rounds to be fired from various other guns, and the result was what I have told you"?—Yes.

3459. Then the military authorities seeming to have been perfectly satisfied up to that point, can you explain what were the different conditions under which the gun was tried which made them so suddenly change their mind?—I think it was not the different conditions under which the gun was tried, but merely that at that time they happened to meet with some defective guns.

3460. But they had had experience with the guns and they were satisfied, and suddenly they seemed to have found that their confidence was misplaced?—You must recollect the very large number of guns that are in use, and it was only when they came to use some defective guns to a considerable extent that the defects were discovered.

3461. May not exactly the same results occur again, if the same defective guns continue to be used?—Those are all guns of very early date, and it was very natural at the commencement of manufacture when our experience was small that the guns would be of an inferior quality to those afterwards made; it does not appear to me very extraordinary that a small number of defective guns should have found their way into use.

3462. But I think that Colonel Bingham stated that he thought about one half of the guns were defective?—I see no sufficient reason for that opinion, and I am not aware that he stated it.

3463. General *Peel.*] Were you present at the trials of all the vent-pieces?—No.

3464. Therefore, you cannot tell under what circumstances they have been tried; whether with rapid firing or otherwise?—I dare say I can give pretty full information about them. Perhaps you will permit me to mention the number of vent-pieces that have failed altogether, and then you will find that it is not so serious a matter as is imagined. In the case of the 12-pounder, I find that the total number of failures is 19, the whole of them being made of a confessedly defective metal, that is to say, steel, and the fracture is entirely due to that fact. Out of those 19 vent-pieces, six have failed, after an endurance of 300 rounds each. You must bear in mind that the vent-piece is not expected to have the same endurance as the gun, and if it lasts 300 rounds, it does not do so very far amiss. Then, again, five of them have endured an average of 200 rounds each, and six failed after 7,448 rounds, fired with 30 vent-pieces, which number divided by 30 vent-pieces would give an average of 250 each. Now those are vent-pieces made of a metal which we know to be imperfect, and which we have given up; and until some failures occur with wrought iron, I think we are entitled to assume that the difficulty, such as it was, is entirely surmounted. It appears that at Shoeburyness the number of rounds fired with the 12-pounders is 22,765. I should say that, at least, 35,000 rounds must have been fired during the breaking of those 19 vent-pieces. In the case of the 20-pounders, I find that 10 vent-pieces have failed, and out of those 10, six were actually tested to destruction, that is to say, they were subjected to extra charges till they failed, so that in that case only four can be said to have failed altogether. Then in the case of the 40-pounders, the number of failures has been 45, and of that 45, no fewer than 12 failed in the course of Captain Coles' experiments with the cupola, which is a mystery that we have never yet been able to explain. The whole of those 45 were of the old pattern; not one of the new pattern which was introduced in April 1862 has failed. I cannot ascertain to what extent practice has been carried on with it, but certainly to a very large extent, and I adduce also the strong fact that 1,200 new-pattern 40-pounder vent-pieces have been proved without a single failure. Up to the 40-pounders, I feel I am justified in expressing confidence, and in saying that the difficulty is surmounted. Then we come to the 100-pounders. As we increase the calibre, the difficulty increases. In the case of the 100-pounders the vent-piece is still a difficulty. Experiments are being continued with every prospect of getting over the difficulty; but even if that prospect be not fulfilled, it is only necessary to reduce the weight of the shot and the weight of the charge, because you will bear in mind that our 110-pounder is only a ton heavier than the French gun, and that we are using a charge 2½ times heavier than that of the French gun, therefore we can afford to make a reduction, and still have a very powerful gun. If the charge, instead of 14 lb., was 10 lb., and the shot 80 lb. instead of 110 lb., my opinion is that we should have a vent-piece competent without any difficulty to bear the strain. I have some photographs here of broken vent-pieces, which will show the Committee that the death of a vent-piece is not so serious a matter as may be thought. These are, so far as I can ascertain, all the photographs that have been taken, and they show very clearly the nature of the fracture, both in the case of steel and that of wrought iron. In the steel you see a piece broken off, and the crack is of a very decided nature; it is peculiar to steel that it is more liable to break in pieces than iron; the rest are all wrought iron. No wrought iron 12-pounders having failed, I have none to produce. But these are photographs of 110-pounder vent-pieces which have

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have been condemned, perhaps you would wonder what is amiss with them, but when they are very carefully examined small flaws may be perceived. You may go on firing with them in this state for some time, for the vent-pieces give notice before a failure takes place.

3465. Mr. *Vivian.*] Are those photographs of the vent-pieces alluded to in page 2 of Appendix No. 14, "Failure of three wrought iron vent-pieces" in Her Majesty's ship "Emerald," Queenstown"?—No; these are all from Shoeburyness. These are vent-pieces that are included in Colonel Gardner's statement.

3466. Those are not the vent-pieces that were "cracked in firing 33 rounds, of which nine were blank, and a steel vent-piece in constant use remains uninjured"?—Some of the steel vent-pieces seem to be imperishable, but the metal is so uncertain that we get a larger per-centage of failures; wrought iron always bulges or cracks before it actually breaks. Therefore, this is not a question of accident. I do not call them accidents at all.

3467. Sir *John Hay.*] There are no means of ascertaining before-hand, whether a steel vent-piece will be a good one or a bad one?—None at all.

3468. Have you had your attention drawn to the Report of the Ordnance Select Committee, contained in No. 14 of the Appendix: "No. 1063 fired three rounds of 11 lb. charge, and one round 14 lb. charge, when it split through from back to front, and the cross head was blown off"?—Those appeared to me to be damaged vent-pieces that were subjected to a further proof.

3469. I think three wrought-iron vent-pieces appear to have failed in Her Majesty's ship "Emerald," which were submitted to the Ordnance Select Committee for their report, and then the Ordnance Select Committee report upon them in that way?—If I understand the matter rightly, it is this: that three vent-pieces cracked, much in the same manner as those photographs show, had been sent to the Committee to see what amount of firing they could bear in that state, and then the Committee subjected them to those trials. "Those vent-pieces were forwarded to the Committee, who decided, after communication with Sir William Armstrong, to deliver them over to the Inspector of Artillery to be subjected to further firing, to ascertain how far the fissures which appeared externally, extended through the substance of the iron, and were of a dangerous character. The results were reported by Lieutenant-colonel Strange on the 7th July, and will be found stated in the annexed abstract." Then follows what the vent-pieces bore in that state: "No. 1063 fired three rounds of 11 lb. charge, and one round 14 lb. charge, when it split through from back to front, and the cross-head was blown off." That was a cracked vent-piece to begin with. "No. 989 fired four rounds with 11 lb. charge, and seven rounds with 14 lbs. charge, when the crack opened so much, that no more rounds were fired, for fear of injury to the gun. No. 1096 fired three rounds with 11 lb. charge, and 40 rounds with 14 lb. charge, when the increase of the width of the crack rendered it difficult to remove the vent-piece, and the further test was stopped." Those were merely tests to prove what a broken vent-piece is capable of sustaining.

3470. They are wrought-iron vent-pieces originally broken on board the "Emerald?"—Yes, cracked in the manner which those photographs show.

3471. Will you kindly refer to the next paragraph in which the Committee express their decision?—"The Committee are not aware of any other direct conclusion that can be drawn from the occurrence than that wrought-iron vent-pieces have a less uniform strength than was at first imagined; very few of them, however, comparatively speaking, have failed; and none, so far as reported to the Committee, since the introduction of the (C) crescent Swedish iron. The only explanation Sir William Armstrong can offer is that the vent-pieces must have been defective, but it is not apparent what the defect is."

3472. Captain *Jervis.*] I think the first paragraph in your instructions as Engineer for Rifled Ordnance was, that you were to mature and perfect your system of rifled ordnance?—Yes.

3473. And part of that system was this question of the vent-piece, which was to last so many rounds?—Yes.

3474. The vent-piece was never supposed to last so long as the gun?—No, certainly not.

3475. Part of the regulations of the service is that so many vent-pieces are furnished to each gun?—Yes.

3476. Therefore, your great point was to see if you could get them to last as long as possible?—Yes.

3477. They must give way sometimes?—No, I do not know that; I think the 12-pounders are almost imperishable; at least, we are not to assume the contrary.

3478. But that was part of the gun which you were to mature and perfect?—Yes.

3479. At first they were not in a very sound condition?—No, it was a mistake to use steel, and we were led into it by the fact that steel had stood in the experimental guns.

3480. Colonel Bingham, in his evidence, his attention having been called to certain defects, said, that they had orders from the War Office to fire 100 rounds to try every field gun in the service?—Yes.

3481. In all the experiments made at Portsmouth, and also Shorncliffe, only one vent-piece gave way in the whole transaction?—Yes, I believe that was the case.

3482. Can you say how many of the 110-pounder vent-pieces broke altogether?—Forty-three 110-pounder vent-pieces have failed, but out of those 43, 10 were with exceptionable charges, in the course of experimental practice, in some cases with charges of 25 lbs. of powder, which it was never contemplated should be used; therefore 10 have to be struck off, which would reduce the number to 33.

3483. Can you say out of how many that is?—No, it would be out of a very large number. But undoubtedly that liability does exist to a greater extent in the 110-pounder than in any other gun.

3484. I suppose going from one calibre to another, you find that all those matters require a considerable amount of investigation and patience?—Yes.

3485. The larger the gun the greater the difficulties in your way?—Yes; and the weight of the vent-piece of the 100-pounder imposes a limit upon the practicable thickness. If you made it of an ample thickness, it would become so inconvenient to lift that it would be difficult

difficult to work the gun, and that is obviated by the wedge arrangement. I was about to state the total number of vent-pieces that have failed altogether; it is, as far as I can ascertain, 117 of all kinds, including failures and experiments under exceptional circumstances, and with all the disadvantages of the early trials. Now the total number of rounds that have been fired at Shoeburyness alone amount to 37,184.

3486. *Chairman.*] Colonel Gardiner says, in answer to Question 110, "I cannot tell you precisely what number of vent-pieces have been broken since I have been acquainted with the experiments at Shoeburyness. There is a return which, of course, the Committee can call for, but I think they would be found to be between 60 and 70 altogether." Then he was asked, "Do you mean since 1859," to which he replied, "Perhaps there have been more since 1859, because in the first instance the records were not very acurately kept"?—I have the total number of the vent-pieces that have failed everywhere, and the total at Shoeburyness, from first to last, is 67, and the total number of rounds fired 37,184. The total number of vent-pieces altogether which failed in all quarters being 117, and I should think not less than 60,000 rounds have been fired. That is an approximation, of course.

3487. Major *O'Reilly.*] You mentioned on the last day of your examination that one of the results which had been obtained by the country had been a system of construction of guns; will you kindly say whether you mean by that the system of strengthening the guns by hoops of wrought iron, or whether you include the system of constructing the barrel?—I referred to the coil system.

3488. You referred both to the barrel and the external hoops?—It is applicable to the barrel and to the hoops.

3489. Then what do you mean by the coil system as applicable to the barrels and the hoops?—The gun with the barrel of steel as exemplified in my first gun, or with the barrel of coil, as in my subsequent guns.

3490. What is the system of construction which you say the country has gained?—The coil system; but I have made the internal tubes of the gun of both steel and coils; I use the coil as an alternative when steel is not to be obtained.

3491. Then how do you define the system of construction which you referred to?—The construction of the gun by a system of coiled tubes. I have already stated that the system which I most approve of is to use steel for the barrel, provided I can get the proper metal; but if it cannot be got, then the alternative is to use coils for the barrel as well as for the external parts.

3492. But in speaking of the system, I want to know what mode of construction of barrel we have obtained?—You have got specimens of guns constructed in both ways.

3493. But a system would not consist of specimens of guns?—The system is that of constructing cylindrical tubes of coiled iron, and combining those tubes together, so as to form guns.

3494. Combining that with whatever barrel is best?—Yes; that is the variation of the system; the question being whether to apply a steel barrel or a coiled barrel; the coiled barrel does very well, but I do not consider it perfect.

3495. You also mentioned as a result obtained, a system of guns and ammunition. Would you kindly define that further as to its essential part; it consists of polygroove rifling, but the breech-loading is not essential, you say?—The essential part is the construction; I think the mode of rifling is subordinate; the most prominent feature is the construction.

3496. Then, am I right in concluding that the question of the breech-loader or muzzle-loader is not essential in your system?—Yes; neither mode is peculiar to my system. I think that the relative merits of the breech-loader and the muzzle-loader is a very difficult question.

3497. Is the question of using soft coated shot an essential part of the system?—Yes; not the coating, but using a soft material for giving rotation; it may be in the form of a continuous coating, or in the form of studs.

3498. Sir *John Hay.*] A soft bearing?—Yes, that I do certainly pledge myself to.

3499. Major *O'Reilly.*] Those are the only points which you consider essential?—The essential points are the mode of construction, and so far as the principle of rifling is concerned, the using of a soft material.

3500. Will you tell the Committee what amount of success you think you have obtained, with respect to muzzle-loading in the shunt gun?—I feel very great confidence in the shunt principle of rifling.

3501. Can you state how far that has been tested?—That principle has been tested by myself privately, and by the Ordnance Select Committee. My own private experiments (I speak more especially of recent experiments) assure me that I can attain equal accuracy and equal range without any of the disadvantages that have been attributed to breech-loaders.

3502. Mr. *Beecroft.*] Is it not now nearly five years since you began to make the Armstrong guns on a large scale?—It is since 1859, I think.

3503. You stated, in answer to Question 3232, that this kind of manufacture was not so well understood then as it is now?—No, certainly not.

3504. You state that the difficulties met with were very great; was it so?—Yes.

3505. During those five years you have gained much valuable experience, no doubt?—Yes.

3506. Does that experience enable you to make both better and cheaper guns?—Yes.

3507. It appears from the general evidence given, that large rifled guns require something which it is very difficult to obtain, more especially for the inside of the gun?—No doubt.

3508. It appears that you have not determined in your own mind, whether you prefer the coiled principle, or a mild steel?—Yes, I have quite determined if I can get steel of proper quality, that that is preferable.

3509. If you can get the steel uniform and of a proper quality?—Yes, that is uniform one time with another.

3510. What I mean is, that it should always be to be depended upon?—Yes, without any percentage of failures.

3511. In that case you prefer mild steel or homogeneous metal to the coiled iron for the inner tube?—Yes, and that was my original view; the first gun I made had a steel tube.

3512. Must not the working of that materials, and the treatment in and out of the furnaces, require great skill on the part of all concerned?—

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With respect to the general making of the gun, yes.

3513. Must not the stability of such built-up guns also greatly depend on the accuracy with which the guns are fitted together?—I do not think there is very great accuracy required in the mode of manufacture.

3514. Not in the fitting?—No, it is a matter of shrinkage.

3515. Must not the shrinking be done with great accuracy?—There is no difficulty whatever about it; a small variation does not involve very bad results.

3516. Is it not chiefly in the mechanical properties of the gun that the great difficulty lies in the construction?—I do not understand the question.

3517. When the gun is rather complicated, are not the mechanical properties very great?—No, the difficulties in the construction of the gun chiefly arise from the defects of the material. Now that we know how to proceed, there is no difficulty in the case at all, if we can get the metal. Originally there was a difficulty, as we had our experience to obtain.

3518. Previous to the introduction of your built-up gun, the service guns were made of brass and cast-iron, were they not?—Yes.

3519. Casting guns, either of brass or iron, is a very simple process, is it not?—Yes.

3520. Is not gun-founding an old-established trade in this country, carried on successfully for many years?—Yes.

3521. Are you aware that the Government set up a foundry for casting guns in 1856, and that it turned out a failure?—Yes; I am aware that they set up a manufactory, and that very few guns were made.

3522. Was that on a very large scale?—Very large indeed.

3523. Are you aware that the Government actually stopped their own gun-founding, and still obtained large quantities of cast-iron guns from contractors?—Yes.

3524. Was the iron gun-casting under the superintendence of a military or a civil officer?—A military officer.

3525. Was it with your approval that General Peel selected Mr. Anderson to be your assistant?—Yes.

3526. It has been stated in evidence that, so far as the conducting of the Royal Gun Factory was concerned, you left that entirely to Mr. Anderson?—No, it was not so.

3527. It was not left entirely to him?—Certainly not; it was under a control from me; his duties were those of resident superintendent, but under my general control; all the processes of manufacture adopted there, and all the machinery introduced there, was subject to my approval and direction.

3528. Continually under your inspection?—Under my general inspection.

3529. Mr. Rendel, in his evidence, in reply to Question 1972, "You do not think that the work can be done more cheaply in a private factory?" says "In most cases the Government factory has the advantage of a regular and large supply of work, which circumstance may go far to neutralize any advantages which a private contractor may have in cheaper material and better location. Under the condition of a fair distribution of work, I think a private factory will generally work cheaper than a public one. In the case of the Gun Factory, I may be permitted to say that the establishment is conducted most admirably, and that it is extremely difficult to compete with the establishment carried on as it is. The closest attention is paid to economy; and I know that we have found it a difficult matter to keep our costs down, as we should like to see them, to compare with those of the Gun Factory." Do you concur in that opinion?—Quite so.

3530. Does not the success of a great manufactory depend on the character of the man who is placed over it?—Yes.

3531. I find that, in the Balance-sheet of 1861–62, they spent the sum of 392,000 *l.* in the Royal Gun Factory; do not you think that in that sum there was great room for profit or loss?—Undoubtedly.

3532. The evidence given has all gone to show that the Royal Gun Factory has been conducted with great economy?—Yes.

3533. With other management, might there not have been a loss of 60,000 *l.* or 80,000 *l.* without anyone knowing it?—Yes.

3534. Do you think the Royal Gun Factory should be under the superintendence of a military or a civil officer?—That is a matter of policy about which I think I ought not be called upon to express an opinion.

3535. Mr. *Baring.*] Have you any further explanation to give to the Committee with respect to the guns that were lined, and that failed, or were supposed to have failed?—I am not aware that I have; but I may observe that the lined guns are not uniformly to be considered as untrustworthy guns. I have already mentioned that there are a number of cases in which they have been subjected to very long-continued firing, and have yet remained serviceable.

3536. Have you made any report to the War Office with respect to those lined guns?—Yes; I read it at the last meeting of this Committee.

3537. Do you recommend that fresh barrels should be put into lined guns?—I think it would be more satisfactory if that were done; but, considering that there is no danger to be apprehended from the lining, I think it is a question of economy whether the guns should be condemned or not; I am hardly prepared to give an opinion upon that question.

3538. Can you state what would be the cost of a fresh barrel?—I cannot say offhand; not improbably 10 *l.*, or something of that kind.

3539. And do you think that a new barrel could be put in without impairing the efficiency of the gun?—Yes; the guns could be made perfect if they were re-barrelled.

3540. The outside of the amount of inconvenience, with respect to these guns, would be that if fresh barrels were put in, the cost of them would have to be incurred, and that cost might be, you say, about 10 *l.*?—I have really not investigated the question of cost, but I should suppose it would not be much in excess of that.

3541. General *Peel.*] You have been asked what is the peculiarity in the construction of your guns?—Yes.

3542. I suppose that the peculiarity of construction is that which is referred to in page 2 of Appendix No. 48: "The mode of manufacture ultimately adopted, and which forms an essential peculiarity of these guns, constitutes the subject of a provisional specification, dated the 15th of November 1858, and which has now four months to run." That refers to the patent taken out, and

and which you handed over to the Government? —Yes.

3543. That is the patent which is referred to in the War Office letter, dated the 29th of November 1852, in which the Government state that they still retain in their hands the patent, and decline allowing the Elswick Company, or anybody else, to manufacture according to that patent?—Yes; but I should rather refer to the report which I sent in in 1855, and which I have already mentioned in evidence before this Committee as the definition of the points of which my plan consists. That report, taken in conjunction with the drawings which I have produced, perfectly defines what my system of construction was then and is now.

3544. But I suppose what is still retained in the hands of the Government, who decline to allow any one else to make use of it, is what is mentioned in that provisional specification of the 15th of November?—That provisional specification was followed by a complete specification, which is now held by the Government.

3545. Mr. *Vivian.*] Will you have the kindness to state to the Committee the circumstances under which your 40-pounder and 110-pounder gun were introduced into the service?—Do you mean who recommended them?

3546. Yes. If you will refer to page 176 of the report of last year, I think you will understand my question better?—I presume that it would originate in a proposal from me, followed by a recommendation from the Ordnance Select Committee. I see the passage you refer to is as follows: "The Committee approve of the adoption for the Naval Service of Sir William Armstrong's 40-pounder gun of 32 cwt., 10 feet in length, but propose that it be reduced, when necessary, to a gun of 30 cwt., with a length of 7 feet 6 inches." With respect to the 40-pounder, the adoption of that gun had been determined upon prior to that time; but there were certain points, of weight and calibre and so forth, to be settled, and this Committee was appointed for the purpose of deciding upon those details.

3547. Now, will you state the circumstances of the adoption of the 110-pounder gun?—I see the report proceeds: "The Committee were of opinion that the following description of guns should be made to replace the 32-pounder of 56 cwt., and the 68-pounder of 95 cwt., viz., a 100-pounder of 56 cwt., and a 100-pounder of 65 cwt. The calibre of each of these guns to be 7 inches; the length of the former gun to be 7 feet 6 inches, and that of the latter 10 feet. The Committee were of opinion that the weight of the projectiles for these guns cannot be definitely settled, but must be decided by experiment. They were of opinion that it should be the same for both guns, and will probably be about 100 lbs. The Committee also approved of Sir William Armstrong's proposal to construct a 9-inch gun of 130 cwt., and 12 feet in length. The proper weight of the projectile for this gun must, as in the former case, be determined by experiment, but will probably be about 200 lbs."

3548. When was the 110-pounder gun definitely adopted as the large gun for the Naval Service?—I think about that time, but I have not any distinct recollection.

3549. Can you state upon what series of experiments that gun was approved?—None at all; there was such an extensive pressure for rifled guns at that time, there was no time for experiments; and it was one of the great difficulties which I had to contend with, that I was obliged to produce the guns under those conditions.

3550. Were 673 110-pounder guns, costing between 400,000*l.* and 500,000*l.* to the country, adopted without any series of experiments being made?—No, certainly not; but it was some time before the first gun was ready, and, probably, about 100 guns were in course of construction before we could test one.

3551. Could you, by reference to any paper, give the Committee any statement with respect to the circumstances which preceded the complete adoption of the 110-pounder gun previously to the construction of such a number of them, at such a heavy cost as that which I have mentioned?—I think the Ordnance Select Committee, or the War Office, or the Admiralty, would be better able to answer that question. I have acted throughout merely as engineer.

3552. General *Peel.*] Referring you to page 246 of the Appendix of last year, let me ask you whether it was not under the authority of the Admiralty that those guns were ordered?—I see that the concluding words of the Admiralty letter of the 17th January 1859 are, "I am to request that instructions may be given to Mr. Armstrong to construct as powerful a gun of each description as possible, confining himself to the limits (as regards weight and length) of the guns now in use."

3553. Sir *John Hay.*] The limit of weight was very strongly insisted upon, I believe, was it not?—Very strongly indeed.

3554. Mr. *Vivian.*] My question had reference, you would perceive, to the experiments on which such a large number of guns as 673, costing such a large sum as I have already mentioned, were constructed?—I do not think a very large number were constructed until satisfactory experiments had been made with the 110-pounder.

3555. You probably were present yourself at a great many of the experiments of the 110-pounder gun?—Yes, a great many.

3556. Then, can you state that a large number of experiments were made previously to the gun being actually adopted for either service?—No; the guns were ordered before there was any opportunity of making experiments.

3557. What number were ordered in that manner; can you state approximately?—Very likely 100 guns in the first instance.

3558. Before any experiments were made?—Yes, before any experiments were made, because there was no opportunity of making experiments.

3559. In fact, the whole of the guns had been made without any series of experiments being gone through with respect to their endurance?—No; a great many experiments were made by the Ordnance Select Committee, and on board the "Excellent," with regard to their endurance and everything else. The 100-pounder gun was subjected to an extraordinary proof; it was fired 100 rounds, with shot increasing in weight, up to 1,000 lbs.

3560. Have you yourself ever been satisfied with the vent-pieces of the 110-pounder guns?—No; I have been satisfied with everything but the vent-pieces. I have stated before that I do not consider the arrangement of the guns so perfect as that which might be obtained by a side movement, and that I think the vent-pieces too heavy. When you come to a vent-piece of a

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gun of that size, the weight of the vent-piece becomes a serious objection.

3561. Will you have the kindness to refer to Appendix 14, at page 4, referring to the experiments at Plymouth Citadel? You will find there this passage: "At the usual inspection the vent-pieces stuck, and were so difficult to extract that practice was abandoned after firing six rounds"?—Yes.

3562. Has that been brought under your notice at all?—It is the most trifling thing in the world; it merely means that the cheeks of the vent-piece had been a little too wide: a file would have removed that immediately; taking away the 32d part of an inch would have been sufficient.

3563. But if that were so simple a matter, would not the officers in charge of the experiment have adopted some such means as that to which you allude?—I cannot say, but that is all that is involved in the matter.

3564. Supposing an accident of that kind occurred in the presence of an enemy, would it not be very serious?—But it would not occur now; the liability only existed in the first instance.

3565. Did not all this occur in December 1862?—Yes; but no doubt the gun was an early one. If I had any definite explanation of what the cause of the accident was, I could deal with it, but in the absence of that I can only say, that I can conceive no other cause except an excess of breadth in the vent-piece. I know that, in the first instance, we had to reduce the breadth of the vent-piece in order to give a little more freedom.

3566. There is nothing in the Report of the Ordnance Select Committee, is there, to show that this gun was an early gun, or that the vent-piece was an early vent-piece?—All that I can say is, that the liability does not exist now.

3567. Although it existed in December last? I have no doubt the gun was one of the early guns, and the vent-piece an early vent-piece. At all events, the defect only requires the application of a hand-spike, and it is a very unimportant objection. The serious difficulty with the 110-pounders is the breaking of the vent-piece.

3568. The accidents are summed up by the Committee in these words:—1. "That in the first use of the 110-pounder guns, with service charge, they recoiled and fell backwards. 2. On the next occasion, minor casualties occurred. 3. Subsequently a vent-piece failed. 4. Finally, a gun-carriage gave way, being, as Colonel Shuttleworth observes, an accident on each day of practice"?—I know that it is perfectly unnecessary to have any capsizing of the guns, or, anything of that kind.

3569. The Committee go on to say: "The splitting of the wrought-iron vent-piece of No. 302 is more serious, and the Committee receive, with increasing anxiety, the reports of such occurrences. There have, as yet, been few of these, since the introduction of wrought-iron, and none since the introduction of Swedish iron of D. brand crescent, but it is not to be disguised that the continuance of this system of breech-loading will be endangered if, notwithstanding every exertion to find the best material nature affords, and all proper care and skill in the use of it, such accidents prove to be of frequent occurrence." That report is signed by Colonel St. George, in December last?—But I see that the gun was fired without compressors, and in that case, of course, it would capsize. The report of the Committee explains how the accidents happened. They say, in describing the accidents: "1. That in the first use of the 110-pounder guns, with service charge, they recoiled and fell backwards. 2. On the next occasion minor casualties occurred. 3. Subsequently a vent-piece failed. 4. Finally a gun carriage gave way, being, as Colonel Shuttleworth observes, an accident on each day of practice." Then the Committee proceed to say: "With respect to the first complaint, it has been elicited by subsequent inquiry of Field Marshal His Royal Highness the Commander in Chief, that on the occasion referred to, the two guns which overset, Nos. 307 and 302, were fired with full service charge of 14 lbs., without compressors, or the adoption of other means of checking recoil, although compressors were supplied for the purpose. It is generally expected of officers, that when platforms are wet, or when from any other cause the recoil is inconveniently great, they shall resort to some means of checking it; the simplest of which is to sprinkle sand on the platform, but compressors should always be used if provided. The first round gave full evidence that some such means were required in this instance, and as they were not employed it is impossible to feel surprise at the result." And that seems a complete answer.

3570. But would that result have occurred with an ordinary gun, do you think?—Yes, with any ordinary gun of equal weight.

3571. The officers who fired these guns were artillery officers, were they not?—I cannot be at all responsible for the acts of those officers; all I say is, that it is quite unnecessary to have accidents of that kind.

3572. But from the extreme lightness of those guns, are they not more liable to that kind of accident?—I do not think they are at all too light; there is no difficulty in controlling the recoil; and weight is a very great objection.

3573. You stated that the side breech-loader was satisfactory; will you have the goodness to refer to No. 12 in the Appendix of this year. On page 1, you will see a Report of the Ordnance Select Committee on Armstrong Guns, dated 13th January 1862. The subject of the report being "Sir William Armstrong's 70-pounder gun, with new side breech-loading arrangement." The Committee say, "From the enclosed abstract of practice, it will be seen that the results were unsatisfactory, the variation of range with this gun being greater than with Armstrong guns of other natures?"—That was a matter of a little difference in the rifling of the gun, and has no reference at all to the question of breech-loading. But the Committee did subsequently approve of the gun, and they give the details of the practice with it which were very satisfactory.

3574. I see at page 4, that they say the 40-pounder made excellent practice on the 13th instant?—Yes.

3575. In several instances the screw is stated to have clogged. Examples of that kind will be found in Appendix No. 6, at page 2; does that frequently happen?—It happens to a certain extent in the 12-pounder and in the 40-pounder, and the cause is very simple indeed; the front part of the breech-screw nearly fits the chamber in which it works. There is a space of about $\frac{8}{1000}$ths of an inch allowed all round. The smoke from the leakage is apt to settle upon that part, and to cause, after a certain number of rounds have been

been fired, a stiffness in the screw. As soon as ever that was ascertained, we increased the clearance at that part, and then the liability was removed; but as a good many guns in the service still have a small clearance, they are liable to a little stiffness after a certain amount of firing.

3576. In page 11 of the same report, it is stated that a breech lever was broken?—That is quite possible, but it is a very rare accident. Afterwards we strengthened the handle by increasing the diameter of the screw which secures it.

3577. That instance occurred on the 12th of February 1863?—But no doubt it was an old gun.

3578. Then the guns are continually in process of improvement, are they?—Yes, but it is a very rare accident, and does not disable the gun at all. The handle is merely a matter of convenience, and you can lay hold of the ball almost as easily as you can lay hold of the handle.

3579. At page 19 it is stated that the same accident occurred?—It is quite possible; but all that I can say upon the subject is, that it is an accident that has not been complained of, and is not considered at all serious. The few instances that did occur were met by that small alteration that I have mentioned, and the guns are by no means disabled by the loss of the handle.

3580. Then in Appendix No. 8, you find a report of the experiments made by the wish of his Royal Highness the Commander in Chief, which commences with these words: "The above Committee having assembled, the observations of his Royal Highness Field Marshal Commanding in Chief, as well as letters and reports from different stations, were laid before them; from which it appeared that a number of the service field-guns had become seriously injured in carrying on the ordinary instructional practice, and that other accidents had occurred to the new equipments." Was your attention drawn to this report, in which it is stated that the number of guns have failed, and been seriously injured?—Shorncliffe guns, do you mean; I recollect no other guns that failed except the guns at Shorncliffe.

3581. I see in the report that the Committee resolved to inquire into the nature and causes of injuries with regard to—1st. The six 12-pounder guns which suffered so much from ordinary practice at Shorncliffe?—Yes.

3582. Then it appears that the Committee meet at Shorncliffe, and they give the nature of the injuries which occurred to the guns?—Yes.

3583. Will you kindly refer to the report under the head 20th November: "About three inches of the thread is broken off the breech-screw"?—The breech-screws, like the vent-pieces, were made of steel, under the idea that steel was nearly twice as strong as iron. The thread of the breech-screw was made a little more than half the thickness of the iron, and the result proved that the strength of the steel when opposed to concussive action was not superior to that of iron; the most advanced threads of the screw were found liable to crack at the neck, but the cracking never extended so far back as to endanger the coming out of the screw; of course however, that was a defect, and as soon as we ascertained its existence, it was remedied by the use of a bevelled screw with a vertical face on one side, and a sloped face on the other, upon which the liability to which we have been referring entirely ceased.

3584. But has there not been any experience of that?—Yes, all the 40-pounders for a very long time past have been with that thread, and the whole of the 100-pounders, and there has never been a single case of failure.

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3585. But the field-pieces are of the old construction?—Yes, the early guns.

3586. Up to what date?—There have been none made for a long time.

3587. But I am asking with respect to the field pieces?—The whole of the 9-pounders have been made with the corrected screw; the land service 12-pounders were all made with a square screw, because none of them have been made since the defect was found out, but they all admit of being altered without difficulty.

3588. But still that defect does run through the whole of the field service guns at this moment?—Yes; but it is not a serious defect, and the guns are not disabled by it.

3589. But they would be disabled by firing, would they not?—After a very long period, no doubt but it is a very progressive action.

3590. The next gun appears to have failed behind the trunnion. "The part of the gun behind the trunnion has receded from the remainder of the gun ·8-inches carrying with it the lining or bouche, a distance of ·6-inch"?—Yes; that was entirely owing to the weakening of the gun by the introduction of the lining. It divided in the first layer in consequence of the reduction of the thickness of that layer.

3591. All lined guns are subject to that, are they not?—Yes; but it is the only one that has failed in that way.

3592. But are not half the field service guns lined?—Partially; not completely.

3593. So that a very large number are liable to that defect?—That is the only instance in which it has has occurred, therefore it cannot be a very imminent defect.

3594. The next gun appears to have failed at the 12th round. "At the 12th round from this gun the bouch was observed to project slightly at the muzzle. The projection increased with the firing, and, at present time, after 34 rounds, it is ·14-inch from the face of the piece. A corresponding vacancy is left behind"?—That, again, is attributable to the lining.

3595. Is that the same nature of failures?—The same cause of failure, not the same nature.

3596. *Chairman.*] Is that what is meant by a gun lapping out?—Lapping out is grinding.

3597. Mr. *Vivian.*] The next gun in the battery appears to have failed in this manner. "17 rounds were fired from this gun, when it was considered unsafe, from a long crack in the coil behind the trunnions"?—That, undoubtedly, was from defective material or defective manufacture; it was one of the very earliest guns that were made, and I am not at all surprised that there should be a few defective guns of that kind. That, again, is the only instance in which the thing has occurred; and it gives this satisfactory result, that you see we can have a very extensive fracture, and still the gun does not burst.

3598. Upon what do you found your statement that it was an early gun?—Upon the number of the gun.

3599. The number of this gun is 287?—About 800 have been made of the 12-pounder gun, I think.

3600. General *Peel.*] How were the numbers arranged?—As they were made.

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3601. Were there two different numbers, one for the Elswick Company, and one for the guns that were made in the Arsenal?—I do not recollect; but I think there were two separate series of number.

3602. Mr. *Vivian.*] Then it could not have been a very early number?—There were others earlier.

3603. There would be No. 286, that would be earlier, I suppose?—I am quite satisfied that such liability has not existed for a long time; but it did exist in the first instance, and that is a solitary example of the occurrence.

3604. In the K Battery, gun No. 153 had "one vent-piece (steel No. 701) much broken, and the upper part blown away?—That is a failure of a steel vent-piece, and no doubt they are liable to failures.

3605. Gun, No. 250: "Two flaws through the gun, at 39 inches right of up. The fouling came through during the practice." That must have been a serious failure, must it not?—There is no doubt those were all defective guns, and it can only be explained by the very deficient experience of the establishment at the time those guns were made.

3606. But still they were a fair sample of the average guns, were they not?—No, certainly not.

3607. They were not selected?—The proof that they were not a fair sample is that other guns in constant use are not subject to those defects.

3608. But this examination was undertaken on the ground that other guns were defective?—But I assure you it is not the case; it is the only instance that is reported.

3609. The report commences by stating, "that a number of the service field guns had become seriously injured in carrying on the ordinary instructional practice"?—Yes, but this is the "number" that is referred to. I do not derive from this paper that there was any other "number."

3610. But in the evidence of His Royal Highness the Duke of Cambridge, he alluded to the number of guns that had failed throughout the service?—Perhaps you will direct my attention to any instances. Those are all that I know of; anything else that has been brought to my notice has been of a very trivial character.

3611. It appears that four guns, about which there seems to be some doubts, were withdrawn from those two batteries, and that four other guns were sent from Woolwich?—The K and I Batteries are the batteries that were used at Hilsea.

3612. Mr. *Baring.*] With respect to the four guns, you will find in the report of the Committee these words: "Moreover, owing to the circumstance of the Inspector of Artillery being unacquainted with the history of the guns manufactured in the Royal Arsenal, that officer sent, by mistake, to Portsmouth, just before the late experiment, four patched-up guns, to replace guns of a similar description, considered unfit for the trial"?—Yes.

3613. *Chairman.*] It is given in evidence by Colonel Strange, that only one of the guns is said to have been lined?—Yes, but that is not the fact; the four guns were all lined guns, and they were sent down without knowledge of their being lined.

3614. Mr. *Vivian.*] The question (No. 1973) put by me to Mr. Anderson is this: "You were asked whether Nos. 153 and 250 were lined guns?" and he answered, "No. 153 is not a lined gun." Then I asked him, "Is No. 250 a lined gun?" and he replied, "No, that is not lined." Those are the guns with respect to which I was examining you in reference to the I and K Batteries?—Those are the batteries that were tried at Portsmouth. Hitherto you have been speaking of Shorncliffe, have you not?

3615. No, I was examining you entirely upon this paper?—But the Honourable Member will observe, that the Portsmouth guns did not fail.

Jovis, 4° *die Junii*, 1863.

MEMBERS PRESENT:

Mr. Beecroft.	Mr. Laird.
Mr. Dodson.	Mr. Monsell.
Sir John Hay.	Major O'Reilly.
Captain Jervis.	Sir Morton Peto.

THE RIGHT HONOURABLE WILLIAM MONSELL, IN THE CHAIR.

Captain ARTHUR WILLIAM JERNINGHAM, R.N., called in; and Examined.

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3616. *Chairman.*] How long have you been in the service?—Forty years last month.

3617. How long is it since you have turned your attention to naval gunnery?—Since 1835.

3618. Have you had experience not only of naval guns but also of garrison and field artillery?—I have had experience with field artillery and partially with garrison guns.

3619. How does it happen that you have had experience with both?—I was instructed in the "Excellent," as lieutenant in the use of a field battery and fieldpieces, and have used them on service. We had a field-battery of six guns, two of which were Armstrong 12-pounders. We had also a half-battery of Armstrong guns, viz. two 20-pounders and one 12-pounder on a platform which I erected near Staddon Fort, on the east entrance of Plymouth sound, for the instruction of the seamen gunners in firing from the shore, whilst others were being instructed in firing from the "Redwing" gunboat outside the Breakwater.

3620. How long were you in command of the "Cambridge" gunnery ship?—Five years and four months.

3621. I need scarcely ask you whether you have had a great deal of experience of the working and character of the rifled guns?—Yes.

3622. Will you kindly give to the Committee the benefit of your opinion with respect to the different sorts of rifled guns that have come under your notice?—The only experience that I have had has been with the Armstrong 12-pounder, the 20-pounder (originally issued as a 25-pounder), the 40-pounder, and the 110-pounder. As to the 12-pounder and 40-pounder, when the range was accurately known, their precision of fire up to 2,300 yards was certain at an object about 15 feet square, and at smaller objects within that range from the shore, and exceedingly good from a gunboat when under weigh.

3623. Was there a gunboat attached to the "Cambridge"?—Yes; the "Cambridge" had a gunboat that went out every weather regularly, except it was so wet as to make it inconvenient for the men's health in remaining too long exposed to the weather.

3624. The gunboat went outside the breakwater?—Yes; and I always tried to select bad weather when I could get a chance. On some occasions I have been obliged to stop the screw, from the pitching of the vessel, and the fear of injuring the machinery.

3625. And still, under those conditions, did you find that you were able to calculate the distance with great accuracy?—When under weigh with as much accuracy as you could expect to get under the circumstances; but the "Cambridge" was a training ship, and sometimes we might have very good shots among the men, and at other times very bad ones; sometimes I made the men practice firing from known ranges, the vessel being at anchor, when the practice was very far superior to the former. The judging of distance is one of the chief difficulties of a gunnery officer.

3626. Still I presume you would generally have rather better on the average than might be expected in time of war?—Decidedly, as the class of men as a body are superior to the raw levies in time of war. With the exception of a trial with the 40-pounder in the latter end of 1860, when I caused 195 rounds to be fired without any material check, I scarcely remember any instance in which there has not been some check. By a check I mean a delay from some fittings being deficient, which would be very undesirable in action. These arose principally from the carriages and elevating gear being experimental, and through the delicacy of the sights getting damaged, from occasional misfires, from premature bursting of shell, or no bursting at all. In addition to this, the sights are too complicated for general use, requiring more than ordinary promptness and coolness, even in ordinary practice, irrespective of excitement in action. I believe that most of these defects are capable of early remedy, if there could be a joint action between those that have the supervision of the working of the gun and its appliances, and those who have the supervision of the fittings. I do not include in this the defects in fuzes and durability of lead coating projectiles, as to which, when the former have been perfected, both must require time, transport, and change of climate to test their capacity of remaining as good as when first manufactured.

3627. But even without reference to change of climate, did you find the fuze satisfactory?—I know many instances where there has been a premature burst, and no burst at all.

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3628. But on the whole, without reference to the question of change of climate, could you say that the fuzes are fuzes in which you would have confidence in time of war?—I would rather trust to the old fuzes.

3629. Could the old fuzes be used with the Armstrong guns?—No.

3630. Then the result of what you state is, that, so far as your knowledge goes, there is no fuze at present for the Armstrong gun in which you could have complete confidence in time of war?—Previous to my leaving the "Cambridge," things always appeared to me to be changing; we were always getting new things, which were said to be better than the last.

3631. Captain *Jervis.*] When did you leave the "Cambridge"?—On the 1st of May last year. I have been speaking principally of the experience there with the 40-pounders and the 12-pounders. I have never had any strong feeling in favour of the 110-pounder. Though I have no recollection of any accident to the vent-pieces of those guns in my own experience, I know of sufficient casualties with others to make it very desirable that the defect should be got over. I mean to say that I have seen vent-pieces that have been cracked and broken, but I have never heard of any that have actually had pieces blown back so as to injure the people in the rear; but it is not a pleasant thing even to have vent-pieces that crack or split.

3632. *Chairman.*] Or any jamming?—I have seen a jamming of the vent-pieces from those tin-plates. When I gave up the command of the "Cambridge" 13 months ago, I left with the impression that heavy breech-loading guns were still an experiment, and I say so from my impression of the immense explosive force and the large charges of gunpowder, compared to the smaller charges acting upon the rear of the gun; the powder acting like a blow. When the vent-pieces have been made so soft as not to crack, there is a tendency to bend, and a probability of jamming. When they are made so highly tempered they become brittle, they are apt to crack; that is my impression. With regard to the eight cwt. 12-pounder and the 32 cwt. 40-pounder, I believe that, with simpler sights and proper carriages, they will be of great value in warfare, but it will be of a special kind.

3633. Will you explain what you mean by a special kind?—Those guns are extraordinary in precision of accuracy in practice when the range is well known; in fact, from one of those guns from the shore up to 2,500 yards, the range being accurately known, I believe you might hit almost the smallest boat afloat; but when the distance is not known, you have no greater advantage with the Armstrong gun than you have with the smooth-bore, excepting in range. Then with respect to range you might be required, on special service, to take up a position to outflank an enemy, you being afloat, or you might land in some place; and you could actually fire at considerable ranges and molest them although you could not see them, provided you knew your exact distance. I believe that too much has been yielded to the fancy of the mechanic in finishing up the guns, and too great a nicety sought for in the sights, by trying to obtain perfect precision in practice (overlooking the rough usage that all guns must be subjected to, whether ashore or afloat), with the constant alteration of range and complications of elevation and deflection by minute allowances, which might be simplified; I think more should have been left to the skill of the properly trained gunner. With regard to the carriages, I have every reason to speak favourably of the Armstrong recoil carriage, commonly called the Grasshopper carriage (*producing a drawing of the carriage*). The angle of recoil is there 22 degrees, but I elevated a gun two degrees more, on purpose to try the effect of the injury to the carriage: and I have here a long written report of the trial that I made of the 40-pounder, in which the guns stood very well, except that we drew the pivot-bolts in the deck; but it was a question of mechanism, and the War Department thought they could remedy that by renewing the bolt on the same plan again; but it might have been very simply replaced on a stronger principle if they had acted on my suggestion. It is not a kind of carriage which could be recommended under all circumstances, but it is a good carriage of its kind. With regard to the elevating gear and other appliances, they all appeared to me, when I left the "Cambridge," to be under trial and incomplete. Indeed, with the exception of the 12-pounder and 40-pounder guns themselves, of which I entertain a good opinion, I never felt otherwise than that all the appliances were crude and capable of improvement, and of being much simplified; even the carriages on which those guns were mounted were defective in their gear. I never saw a perfect 12-pounder carriage yet, and I never saw a 40-pounder carriage fitted so that you could use the elevating gear without loss of time, so far as I can recollect. With regard to the 110-pounder Armstrong shell, I have a great respect for it, as it carries eight pounds of powder, which if properly applied will create most important results; but, until the vent-pieces can be got to stand, I should wish to have a 68-pounder at hand as well; I have no fear of the gun or the screw giving way. I do not know what the endurance of a 110-pounder may be, but I know that 300 rounds with a cast-iron gun will cause it to require reventing; and from the conical form which the vent assumes near the bottom of the bore, it is prepared to split up; and nearly every cast-iron gun that is burst behind the trunnions splits up the vent as if the charge acted as a wedge to split it open.

3634. Will you favour the Committee with your opinion upon any other points that occurred to you?—I have heard remarks made about the difficulty of firing afloat. I should think that all firing afloat is like shooting flying, and requires great experience.

3635. Mr. *Beecroft.*] What size guns are you alluding to?—Any guns.

3636. The 110-pounders?—Yes; the 110-pounder is very accurate in its practice when you have got the range.

3637. I understand you to say that you have no great opinion of the 110-pounder?—That has nothing to do with the accuracy; I speak of the safety. I am not at ease about the vent-pieces, for I have seen so many that have been broken. But I was going to say that, during the 38 years and odd months that I have been constantly employed, I have spent the greater part in the practice of gunnery; and though I might expend a pound of powder in a day's shooting, and feel perfectly content at bagging a brace of birds, yet I have given so much attention to shot-practice with heavy guns, that I feel certain that with the sights simplified I would match myself against any

any pitched shot at sea under weigh with the finest appliances of the present sights. I mean that not as a boast, but I want to show the absurdity of bringing these sights to minutes. They are marked to six minutes, a degree is divided into 10 parts, each of which consists of six minutes, and you get a table of ranges given to you to fire at those respective elevations of infinitesimal portions of a degree. The next thing is, that the sights are constructed on the same principle as those of the Armstrong guns which were first made. The first sight was cut like this (*producing a slit card*). You have to bring the point of the dispart in the centre of this cross, and if anybody will look through the slit, they will see directly that the measure is infinitesimal; but we on board a ship have to fire guns at the extent of the trigger line, which measures seven feet. I have shown that in the Arsenal over and over again in the sighting-room. If you take a pin and prick a hole through a card, and put your eye close to it, and take the top of (say) that candle which I see before the Chairman with a mark against the wainscotting, and then retire to seven feet, you will find that the mark is above the candle, because you cannot bring your eye down to so small a point at that distance, and that makes nearly the sixth part of a degree. I presume it is refraction, or something of that kind. The next objection is that you cannot see between decks to set these fine sights, and if at the same time the smoke has got right into the decks with the sight between the eye and the light through the port, you must take the sight out to look at it, and then put it in by the rule of thumb. The tangent screw for deflection is of little use, because it cannot be properly applied.

3638. *Chairman.*] Will you now proceed to the next point?—I should like to say something about ricochet firing. One difficulty in the use of the Armstrong gun is that unless you hit in the first instance, you have no chance of hitting, or at least very little chance. There is no ricochet firing that would be likely to help you unless you ricochetted very close, as the shot tends always to deflect away to the right. Whilst I was in command of the "Cambridge," the Commander in Chief was written to, complaining that I had put a shot through a sloop's mainsail that was at an angle of 45 degrees from the object I was firing at, the vessel being a distance of 1,500 yards from that object. I was firing at a distance of 1,100 yards, and a shot struck the rock and we lost sight of the shot's fall in the water, and thought no more about it. A few days afterwards I went on board the sloop and saw the master of her, who showed me the hole in his mainsail about six feet from the deck where he was sitting at the time; but that would occur with any rifled shot.

3639. With any elongated projectile?—Yes. With regard to the endurance of the gun, I have a very strong opinion in favour of its endurance, because I tried an experiment with a 12-pounder Armstrong gun by laying it upon a wharf at dead low-water, which was five feet above the bottom, and the gun rested its whole weight on sand and shingle and gravel. It was loaded with the ordinary charge of powder and shot, and hermetically sealed; and I waited till the tide flowed six feet over the top of the gun, making the depth of water 10 feet. The gun was fired, and the shot ranged 35 feet, and the gun recoiled seven feet six inches, and neither the vent-pieces nor the the gun, or any portion of it, was injured. I did that on purpose to test the strength of the gun, and also to see what the results would be of a shot being propelled under water. I also found my opinion with respect to the endurance of the gun (I speak of guns under 40-pounders) on this: there was an 18-pounder at Shoeburyness when I went though the course some few years ago, that had been fired 3,000 times at least. I was given to understand so, and I believe it was so.

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3640. Sir John *Hay.*] And was it still in good order?—Yes; I saw it used.

3641. *Chairman.*] Had the vent-pieces of that gun been changed?—I should think that they ought to be. The guns and vent-pieces of the 12-pounder on board the "Cambridge" were refaced over and over again. There is one very serious consideration with respect to all the Armstrong guns, and I should say almost all rifled guns: How are you to draw them if they are loaded with shell, and you are going into harbour? Nobody would like to lie alongside a ship with her broadside loaded with shell. I have no doubt an instrument could be constructed to draw the shell from the Armstrong breech-loader. If you had a ring on the end of a rod, and put it against the nozzle of the shot, and you had two bars along the length of the gun outside with the aid of the breech-screw in the rear, you might screw it back; but it would not be a comfortable thing to do, because, if it happened to be a percussion fuze, and by any unforeseen casualty it should explode, the discharge would be inwards as well as outwards, and in all rifled guns you have no means of drawing a percussion shell. With the smooth-bore guns we can, with a little contrivance, draw the shell. I will now speak of the vent-pieces being blown out; I never saw any accidents occur to the vent-pieces of the 110-pounder, although I know it has occurred; I have had one 40-pounder vent-piece cracked, and I had a diagram taken of it, besides sending it back, and it was starred off from the centre; I have seen two vent-pieces blown out of the breech of a 20-pounder and a 12-pounder (I am not quite certain whether they were not both 12-pounders, but they were both small guns), and one of them was never recovered; I am not sure, but I think the other was.

3642. Have you had much experience of the effect of rapid firing upon the vent-pieces?—In the 195 rounds that we fired with the 40-pounders, I think we did fire rapidly on purpose towards the latter end, if I remember rightly.

3643. Do you think that rapid firing has much to say to the strain on the gun?—It has much to say to the manipulation of the gun, which requires great steadiness and coolness.

3644. But as to the strain upon the gun, supposing, for instance, 500 rounds were fired rapidly, would it have a different effect from 500 rounds fired slowly, or fired on successive days?—With a built-up gun I could hardly give an idea, but with the cast-iron gun, I believe, if you allow it to cool, and begin again, it is apt to damage; while if you keep it going the whole time at the same heat, you get greater force of discharge, and more powder is exploded; but it is a question which I hardly feel competent to answer thoroughly.

3645. Will you give the Committee the advantage of your opinion generally with respect to the breech-loader? Are you in favour of the breech-loader?—Decidedly; provided we can make sure of secure vent-pieces, which I think we have in the smaller guns. One of the ad-

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vantages of the breech-loader comes under the head of the question we have just been referring to, which is that the breech-loader is much more likely to be cool after rapid firing than the muzzle-loader; because you have the power of taking out the breech and letting a current of air run through it, besides having the power of cooling it with water inside as well as out.

3646. But if you are in favour of the breech-loaders, and if you consider that the breech-loaders now in the service up to the 40-pounder are entirely satisfactory and reliable, why is it that you consider that the guns ought to be considered as guns merely for special services?—Because I believe that we shall have nothing but iron-plates to fight against; and until you can bring the initial velocity of the rifled guns up to the initial velocities of the smooth-bores, you cannot expect to get the same force to act upon iron-plates.

3647. Sir *John Hay.*] Are you aware that the shortened 68-pounder spherical shot fired with 16 lbs. of powder from a 110-pounder Armstrong gun has a greater initial velocity than the 68-pounder smooth-bore?—No, I am not aware of that; if it be so, then I should be in favour of the 110-pounder Armstrong gun, provided that you can secure the breech properly. The last knowledge that I had of the initial velocity of the Armstrong 110-pounder shot (if I recollect rightly) was about 1,280 feet in a second; whereas I know that the initial velocity of the 68-pounder smooth-bore with a 16-pound charge of powder is about 1,600 feet. I have seen practice with the 110-pounder common shot with the ordinary charge (I think 12 lbs. and not 14 lbs. charge of powder) against an iron-plate, and it did comparatively nothing; and I saw a 68 lb. shot smash it up.

3648. *Chairman.*] Are you not afraid of the complication of the Armstrong breech-loader for actual warfare; do you consider that there would be no risk in relying entirely on the breech-loader for a broadside gun?—So long as a seaman is required to work aloft in all weathers, day and night, fine or foul, to shift a sail in a dark night in heavy weather or stow a flying jib in a breeze, to work a gun on board ship, in a boat, or in a field-battery ashore, to row a boat, take the helm and lead, to act with troops brigaded on shore with the Enfield rifle, to handle a spade and pick-axe, to land guns and throw up a battery, things cannot be too simple, if we are to have the fleet manned by bounty men at 10*l.* a-head.

3649. Take, for instance, the Baltic Fleet at the time of the Russian War: should you have felt much confidence in a ship that was manned as that fleet was, if it was armed merely with the Armstrong guns?—I should have had very little confidence in them; for I can recollect that when I was serving in the Mediterranean Fleet, under Sir Pulteney Malcolm, long before the "Excellent" was established, we used to have naval tactics and firing at a mark, from the fleet cruising round it; and I may safely say that there never was a case but there was a man blown overboard from the muzzle of the gun, from neglect in serving the vent. When I have been asked with respect to the danger of the breech-piece being blown out, I have always said, it will be no longer "take care to serve your vent," but "take care to screw up your breech-screw."

3650. Sir *John Hay.*] Judging from the usual influences that act upon mankind, the number at the breech would be more careful; for the breech is that which affects himself, and the vent is that which affects another person?—Yes; it affects his thumb. I belonged to a corvette many years ago: one man was blown overboard, No. 4 had his right arm blown off, and the captain's cook, who was No. 2 at the gun, in the old gun exercise, had his thumb blown off; but we do not put captains' cooks as second captains at guns now.

3651. *Chairman.*] Will you state your opinion of the different sorts of fuzes?—The pillar fuzes were just being issued when I left the "Cambridge," but my recollection was that they were far too sensitive: a very little caused them to burst; they burst if they even tipped the water. The concussion fuze was equally sensitive. I think the concussion fuze a very safe fuze to be taken on board a ship, because there was a pin in it, which, till it was taken out, was perfectly innocuous, and it could not be put into the shell without that pin being taken out.

3652. Do you consider the percussion fuze to to be a satisfactory fuze?—No.

3653. Now with respect to the time fuze, what is your opinion of that?—That is a very ingenious contrivance, but we never could get them to a longer range than about 2,400 yards. They could not make the composition endure longer than that time. I know that (though it did not come under my experience) from the manner in which the fuze is screwed into the shell, or rather the contrivance for setting the fuze for the different lengths of range, which acted the reverse way to the rifling of the gun; and the immense rotation that the shell had was apt to untwist the screw in the fuze, and to cause a premature burst. Perhaps I may mention here that the rotatory motion of the shot is so great that, in the experiment which I named before, when I fired a 12-pounder (Armstrong) under water, the iron jacket or shot cleared itself of the cylinder of lead which surrounded it, from which I conclude that the pressure of the water outside was greater than the adherence of the lead to the shot inside. I have no opinion of any of the fuzes as likely to be serviceable generally, and to endure; I have stated before that it requires some change of climate to test them. We know that saltpetre and chlorate of potash are apt to suffer from damp, and I know, from examining those fuzes, that though the little metal ring which is in the time fuzes has been sent to us sealed up in tin boxes, and the joint of the lid carefully welded with wax, yet damp has got into them, and you found the ring perfectly corroded; therefore there was damp there, which was likely to affect the fuze composition.

3654. Have you any remarks to make on the peculiar sort of powder used in the Armstrong gun?—He has used a variety of powders. I saw some powder of which the grains were as big as my thumb at Shoeburyness. I do not know the exact component parts, but I believe there has been an error in supposing that it is the powder that causes that thick smoke; because of a special experiment of mine some years ago in the "Excellent," when I thought of preventing the windage of a shot by placing a wedge-formed ring of lead as a wad. We noticed that the colour of the smoke was precisely what we now see from the Armstrong gun, and I conclude that it is some chemical action on the lead that causes that smoke. The smoke is also made exceedingly unpleasant by what it imbibes from the grease on the lubricating

cating wad. On the question of wads I might probably bring into consideration a thought that once struck me, that those wads being made of sawdust and grease, there was a possibility of spontaneous combustion with them. I got the engineer of the gunboat to try them by a test in the engine-room, bringing them up to a very high temperature: we never produced any results. I, however, called the attention of the authorities to it, and I received a letter back to say that there was no fear of that.

3655. Now about the liability to flaws in the Armstrong gun, have you anything to say on that subject?—I do not think that any orders or any notice came out (certainly not to the "Cambridge") to watch the flaws in the guns; but I know that such an order has been issued, and I have seen the guns that have been served out to the Channel Fleet, which I have been called upon to report upon and inspect. I have always felt that I would rather that the manufacturer of the gun should fire it than that I should.

3656. Captain *Jervis.*] You having paid great attention to the subject of gunnery for many years; you would of course remember the condition of gunnery in England about 1854?—Yes, very well.

3657. It was the great desire of this country, if possible, to get a rifled gun which should put us in the same proper condition, with respect to ordnance which the ordinary fire-arms had obtained?—Yes.

3658. And you also know the vast difficulties which there were in the way of arriving at any satisfactory solution of that question?—Yes.

3659. Now looking back on what has been done from that time up to this day, and being aware of the efforts which every European country has made, as well as the United States of America, to arrive at that position in rifled ordnance, do you consider that anything has been left undone to arrive at a satisfactory solution of the question?—I am hardly in a position to say; I can merely speak as a gunnery officer of what I have seen; that appears more a State question than a question for me to answer.

3660. The question we have to look into is whether the expenditure during the last few years is one that should have been incurred, or should not have been incurred. This Committee is directed "to inquire into the expenditure incurred since the beginning of 1858 on various natures of improved ordnance, whether obtained by contract, or manufactured by the public departments, and into the results obtained by such expenditure." Now, you have stated that, taking the question of vent-pieces, or taking other matters, there are certain parts of those efforts which have been made to arrive at a solution of the rifled ordnance question, which are not satisfactory, but do you consider that, up to the present time, any nation is in advance of us in the way of rifled ordnance?—I believe that the French have got a very fair gun at last; it is very cheap; I believe it is an adapted gun, the old cast-iron gun hooped over; and I believe it answers very fairly.

3661. Then do you think that that system might be adopted in this country, and that it would give us rifled ordnance quite as good as we have now, at a very great decrease of expense?—No, I will not say that. But I must confess that when I used to go to Woolwich and see the hundreds of 100-pounder guns lying about there, manufacturing and being issued, it used to strike me that we were going on rather too fast in laying out so much money on those big guns before their perfection was completed. I may be wrong, but that was my impression.

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3662. Do you mean before the idea was complete with respect to the whole of the gun?—No. Especially with respect to the vent-pieces. If he gets over that difficulty, Sir William Armstrong has almost gained his point.

3663. With respect to those guns in the French navy, do you consider that it would be satisfactory to the English navy if they had been supplied with such guns?—I can hardly answer that question, because I do not understand the economy of this matter. Whether it would be advisable, until we got over the difficulty in the breech-loader, is the question.

3664. *Chairman.*] Would you state to the Committee what the French are doing? Is it not the fact that the French are working away, by experiment, to try to discover the best gun; but that, pending the inquiry, they make use of those adapted guns as an expedient?—Yes; they are satisfied with them, I believe, but I never saw them. They are the old guns reemed up to the rifle-bore, and hooped.

3665. Mr. *Beecroft.*] But are not the French cast-iron guns made of charcoal iron of a very superior quality?—I have not the slightest idea.

3666. You are perfectly aware that cast-iron guns made from charcoal iron are much more durable than cast-iron guns made in this country of our ordinary iron?—I am not aware of that.

3667. Captain *Jervis.*] Have you seen the report of the Committee, which has sat for nearly two years, on cast-iron rifled guns in this country?—No.

3668. Wherein they find that no cast-iron gun has been produced, or could be produced, so far as a rifled gun is concerned, without bursting within a limited number of rounds?—I have a very poor opinion of cast-iron guns. I look upon them as very little better than crockery.

3669. It has been found from experiment that hooping with wrought-iron has had no effect whatever in strengthening the cast-iron gun, as the fracture comes from the inside, and not from the outside, is that so?—I am not aware of that, but I can easily imagine that it is so.

3670. You are not aware that it has been found that that plan has a tendency to weakening the gun by the expansion of the wrought-iron against the expansion of the cast-iron beneath it?—Very possibly.

3671. If that be so, would it be advisable to adopt such a system in the navy of this country?—I should have felt hesitation in doing so, but I have heard that the French are satisfied, though I have also heard that the guns have burst.

3672. Do you know that the charge of powder which they used with the cast-iron gun is only one-thirteenth the weight of the shot?—I am not at all surprised at it.

3673. Do you think that you could obtain any real effect with such charges?—Very little.

3674. Am I right in supposing that the wrought-iron rifled guns in our service are superior to such guns as those?—There is no question that wrought-iron guns are the guns that we must always have hereafter.

3675. Therefore the expenditure in wrought-iron guns, instead of cast-iron guns, has been judicious?—When the gun is perfected.

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3676. Then the question in your mind is, as to whether we have gone too fast or not in the way of making rifled guns of large natures?—The impression is that there has been a very lavish expenditure, and that we were constructing enormous quantities of guns of patterns which are experimental.

3677. Is it not the fact that, from century to century, experiments on a large scale have been rendered necessary, because it is only by experience that you can learn anything in the way of gunnery?—That is not my experience.

3678. Do you think it would be advisable to wait till everything had been perfected, say in the 100-pounder, before you made one?—Before you made many.

3679. What is your idea of a perfect 100-pounder?—I do not profess to have an opinion. I am not a gunmaker.

3680. Taking simply the question of a fuze; that has occupied the minds of naval and artillery officers and civilians for many years, and such a thing as a perfect fuze has never been obtained; taking any fuze you please, is not that so?—The old brass fuze was a good fuze of its kind. It had its disadvantages; if you wanted to alter the fuze you had to take it out of the shell.

3681. That was not a perfect fuze?—People want, I think, to get what they never will get. When we began to use the shell on board the "Excellent," there was a great deal of nonsense talked about the fuze. When the range varies the safest way is to cut your fuze so long that it is sure to pass through the ship's side before it bursts, and if it fails to explode it has done the work of a shot. When firing from a fixed and accurately ascertained range the old fuzes can be cut to great accuracy.

3682. But even taking that view, the Armstrong fuze, if not a perfect fuze, is still a great improvement, is it not?—The Armstrong time fuze is a very beautiful attempt, and very ingenious; and, I daresay, Sir William Armstrong may, with his talents, perfect it; but at present we could only get it to act up to 2,400 yards, and barely that sometimes. It had a great advantage, which was, that you could set it after you had put it into the shell; but that had been attempted before, for I recollect seeing a fuze which was the invention of a Belgian officer many years ago on the same principle.

3683. Do you know of any person having brought forward a fuze better adapted for the service, and which you think ought to take the place of either fuze?—I must confess that, as we are situated at present, I am not inclined to give up the old metal fuze till I see something better.

3684. You think that is as good a fuze as the one which is now being made?—If we can get over the difficulties that occur, of the premature bursting and no bursting, and to burn at the longest ranges with the Armstrong time fuze, I say that we shall have a very good fuze.

3685. *Chairman.*] I think you said that this time fuze of Sir William Armstrong was on the same principle as that of some Belgian fuze; but was not the fuze you allude to invented by some one in the Austrian service?—It might be an Austrian fuze; it was a foreign fuze, at all events.

3686. Captain *Jervis.*] I understand you to say that there is a question in your mind with respect to the vent-pieces of the 110-pounders not being sufficiently perfect?—Yes; not sufficiently perfect to bear the concussion.

3687. That is to say, the 110-pounder vent-pieces break more frequently than you think they ought to do?—They have broken with a 12 lb. charge and a 14 lb charge. I am aware, that in order to give the necessary velocity to a shot for the penetration of iron plates, you must use a charge of one-fourth the weight of the shot; and when the increase of the charge is so great, the ratio is incalculable compared with smaller charges.

3688. Supposing it were considered as a matter of policy, iron vessels being found to be stronger than had been anticipated, that it was advisable, if possible, to obtain 100-pounder rifled guns, do you think it would have been right to postpone the making of them, not having any in the service, simply because we broke a few more vent-pieces?—I know that the breaking of the vent-pieces causes very great dissatisfaction amongst the profession at large. I think that the best friends to the Armstrong gun are the gunnery officers; but looking to the service at large, there is a very strong prejudice against them.

3689. But admitting the inconvenience as a matter of expenditure arising from the breaking of the vent-pieces, and admitting that they are not satisfactory, do you think that it would be advisable that we should not have any 100-pounder gun in the navy, simply because we broke a few more vent-pieces?—I should have liked to wait until the vent-piece was complete.

3690. Presuming you to be aware that it has been stated that a different kind of powder from the ordinary powder is used with the Armstrong gun, let me ask you whether you are aware that it is identically the same?—No; I think it is very probable that it is so.

3691. Are you aware why various kinds of powder have been tried?—The object was to endeavour to get a gradual propulsion of the shot out of the bore, so that the powder should be all consumed before the shot left the gun.

3692. Therefore was it not advisable that a variety of experiments with respect to powder should be made?—Most decidedly.

3693. You think it advisable that powder of various sized grain should be tried until we have solved that question?—Decidedly, and I never heard a complaint against the powder. I suspect the powder is a very good powder; it is rather largely grained, but its component parts I never knew, and never thought it worth while to inquire.

3694. I think you have stated that if you could obtain the same initial velocity out of a rifled gun as out of a smooth-bored gun, you would be satisfied to adopt the rifled gun. I suppose you understand that there is no difficulty in obtaining the same initial velocity?—I did not know it before; I am very happy to hear it.

3695. You are aware that the great object with the rifled gun was to get an increased range, and you are no doubt aware that if you get an initial velocity, which leaves behind a greater vacuum than can be filled up by the air, you lessen the range?—I do not know that theory, but I know as a fact, that a heavy elongated projectile propelled with the spinning motion caused by the rifling of the bore, retains a velocity almost equal to its initial velocity for the whole length of the range. Taking a spherical shot with a larger diameter

diameter fired from a smooth bore with a quantity of windage, the shot has an irregular motion. Besides the elongated shot having a greater density and less diameter it overcomes the resistance of the air better than a spherical shot of equal density in consequence of its greater diameter. At greater distances than 200 yards against iron plates with 68-pounders you might as well save your powder and shot.

3696. You are aware that one object in reducing the initial velocity for the rifled gun was to enable them to get an increased range, the velocity being much less than the rapidity with which the air filled up the vacuum?—I do not comprehend the theory, but I know that it takes a greater time for the shot to fall to the ground with slow velocities, and that the faster you make it go the farther it will go.

3697. The greater the initial velocity with which the shot is started the farther it will go, you think?—It ought to do so.

3698. But are you aware that that is not the fact in practice?—I shall be satisfied when I see it in practice.

3699. Are you not aware that you can get the same initial velocity by taking a few more pounds of powder?—I am aware of that.

3700. Major *O'Reilly.*] If the gun will bear it?—We presume that.

3701. *John Hay.*] Do you think that the vent-pieces are liable to accident in consequence of the composition of the vent-pieces alone, or in consequence of the awkwardness of the men who use those vent-pieces?—From sheer clumsiness, just the same as a man blows his finger off in loading full cock.

3702. You think that they arise from want of care?—Precisely.

3703. Then, by the addition of the cross-handle to the vent-piece, which enables No. 2 to see that the vent-piece is in its place, is not that liability to accident avoided?—Just before I left the "Cambridge," we got, I think, a new pattern vent-piece which had some sort of shoulder which was supposed to catch it, so that it did not go down too low. I had occasion to call the Commander in Chief's attention at Plymouth to the necessity of warning captains of ships to have the drill vent-piece for exercise alone, because I found from the hundreds and hundreds of times that that vent-piece was taken in and out at the drill of the pivot gun, and the constant dropping down to the bottom of the bore caused it to flatten up and to slip down. I took very good care that, in the gunboat, the vent-piece was always a good one that we used for firing the gun. With respect to the vent-pieces being blown out, I think nothing about that, because it is entirely owing to the want of proper instruction. What I speak of is the manufacture of the vent-pieces; I speak from my knowledge that so many of them have been broken and been injured. I hope that Sir Wm. Armstrong may get over the difficulty, because I have a very high opinion of the gun if he succeeds in that.

3704. You spoke of the fact that, at the present time there was some hesitation in the navy generally with respect to the Armstrong gun, which hesitation is not shared by the officers and the men who are instructed in gunnery ships?—Decidedly.

3705. But you or any other naval officer, who has been so long in the service, must be aware, I presume, that every change introduced has caused the same hesitation and want of confidence; for instance, that, 25 years ago, when shell firing began to be common, it was almost impossible to get officers to open their shell-rooms, because they considered it too dangerous?—I may mention that I accompanied the Commander in Chief, at Portsmouth, three or four years ago on the inspection of a ship, which had been under a Commander in Chief, whose name I will not mention, but a very old officer, and that Commander in Chief had given orders that the Admiralty instructions, as to keeping the shells between the beams, should not be carried out. I mention that to show you the strong prejudices which, even lately, existed against anything that was new; indeed, at that time, it was old.

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3706. I dare say you remember the hesitation which existed some 30 years ago with respect to using sights at all, the two lines on the gun being supposed to be far superior?—When I first went to sea we had only a sight on every other gun. We all know that fact from James's Naval History. In the action between the "Clorinde" and the "Eurotas," the "Eurotas" was armed with Congreve 24-pounders, there was a small triangular hole in the dispart, and they were instructed to look through that hole. The consequence was that they were firing at two and a quarter degrees of elevation—the Frenchman was all knocked to pieces about his spars and rigging. The action was renewed the next day, and was carried by the seamanship of the "Eurotas," and not by their gunnery; because, at daylight in the morning, she was re-rigged with top-gallant sails set, while the Frenchman had not a stick standing.

3707. And I believe the argument was that the result was owing to the guns having sights?—Very likely.

3708. Therefore, it is to be supposed that, before long, the advantage of rifled guns will be acknowledged by the profession?—They must come in.

3709. I understand you to say that if the breech-loader were perfectly satisfactory, you would prefer a breech-loader to a muzzle-loader?—I have never seen a muzzle-loading rifled gun used. I know that there has been a very strong wish that they should be made; but, if you could get a breech-loader to stand, I do not see why it should not be better than the other: you do not expose your men so much to the fire of the enemy.

3710. And there is less liability to accident in loading, is there not?—I do not know about that; the cartridge is just as likely to explode from the muzzle of the gun as from the breech; perhaps, indeed, it is less likely to explode from the breech than from the muzzle, but a shell might burst at the very moment of putting in the cartridge into the rear of the gun, and you would then be in the same position, with this exception, that, perhaps, numbers 3 and 4, at the muzzle of the gun, would be the only men that would be injured; whereas, in the rear of the gun, an accident might cause great destruction. I do not, however, think that this is a question that can be settled by mere calculation in that way.

3711. If you had your choice, everything else being equal, which gun would you prefer, the muzzle-loader, or the breech-loader?—The breech-loader; no question about it, provided it was all safe. Of course I am saying nothing

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about who is the manufacturer or inventor. I do not care about that.

3712. Do you think that it is an advantage or otherwise that there should be a soft bearing for the projectile?—You mean the lead. I know what Mr. Whitworth's bore is, and I should like to see it tried; but I know what Sir William Armstrong's projectile is, and I know that leaded shot, with the small grooves, gives it a very superior advantage over almost anything that I know of; because it acts like the piston of a steam-engine, working up and down, so that there is no escape of gas through windage.

3713. There is less friction with a soft-coated projectile than if you had two hard surfaces acting upon each other?—I do not like to speak disparagingly of Mr. Whitworth's gun. I do not like to speak about it at all, because I know nothing about it; but my impression is that there will be a grinding at the edges, and after a time, the gun will begin to get worn. I may be wrong, however.

3714. With respect to the initial velocity of the shot from a rifled gun, compared with that of the shot from a smooth-bored gun: supposing the breech-loading rifled gun to be a perfect gun, would it, in your opinion, be advantageous to the profession to have only one description of gun in a ship, with a variety of projectiles, so that you might have a large charge, with a short projectile, with great initial velocity at short range, and a longer projectile, and a lower charge for greater precision and longer ranges?—I do not know how far ricochet-firing will be able to be given up. By ricochet-firing, I mean the chances that you have in favour of the spherical shot striking, by means of the rebound, the object after it has fallen short of it, taking the height of the object at, say 15 or 20 feet. Now I know that all rifled projectiles must hit at once, or else you may say that they miss; but if we are to engage nothing but iron-plated shipping, then we do not require spherical shot; and I recommend these bolts, because they are more sure to hit.

3715. But my question is rather this: Captain Hewlett mentioned the recommendation of himself, and, I suppose, the other gunnery officers to the Admiralty, that a proportion of the armaments of ships should be rifled guns, and a proportion smooth-bored guns; would your opinion confirm that recommendation? — I took your question to suppose that ships should be armed entirely with rifled guns.

3716. No; what I am asking you is this: Supposing we had a perfect breech-loading rifled gun, a gun in which you had entire confidence, would you not then prefer to have a ship entirely armed with that description of gun, and to vary the weight of the projectile, and the weight of the charge for the purposes which the moment required, rather than have two or three descriptions of guns on board one ship?—With respect to the different natures of guns on board ship, I dare say you may recollect that, during the last war, we had one ship, namely, the "Forth," in which there was a mortar for special service, and you may, of course, be placed in special circumstances which may require both natures of guns. We have not yet given up building wooden ships, and we have not yet succeeded in building small iron-plated vessels, so that we may conclude that we shall have to engage wooden vessels, and you will then require the aid of ricochet-firing, which will bring down their masts, or hit them in some form or other, which you cannot make sure of if you have a rifled gun.

3717. The 68-pounder, though a most excellent gun, has only one capacity, that of firing spherical shot at not very long range?—And spherical shell.

3718. And spherical shell; but the other gun (I do not say that we have it yet), which, I conjecture, might be made, might have the capacity of firing a long projectile with very great accuracy, and with a very large charge of powder as a shell. It might also have the capacity of doing what the 68-pounder does, either with shell or shot; and, if it were considered necessary, it might also fire a spherical projectile, weighing about 54 lbs., doing the duty of the ricochet-firing, to which you have alluded?—Do you mean a rifled gun?

3719. Yes. If you loaded it with a spherical projectile capped with lead, with a considerable windage, the one gun having the capacity of performing those three different offices, would you not then consider it better to have ships armed with guns of one description to having different descriptions of guns? — If you could fire a spherical shot out of a rifled gun without injuring the rifling, I should not require other guns, decidedly; I say, if you *could* do that. With respect to lapping the shot with lead, my impression would be, if you coated spherical shot with lead, that when the shot got out of the gun, you would find the shot no longer spherical but of the same shape as a balloon in the air, and that it would go wabbling about to all points of the compass, and lose its direction.

3720. Major *O'Reilly.*] The honourable Member has just asked you whether the old fuzes were not imperfect; am I right in thinking that you stated that the new Armstrong fuzes are less perfect or less satisfactory than the old ones?—That they were less certain.

3721. Is it not the case, that the old fuze cannot be used in the Armstrong guns, from the absence of windage?—In consequence of there being no windage it must be done by percussion; but I do not see any objection to that plan of exploding the Armstrong fuzes. I see no objection to that little contrivance of Sir William Armstrong by percussion; I think it is very neat, very clever, and very safe.

3722. Would you be kind enough to look at paper 12, Appendix No 6, of the return from the "Cambridge?—Yes.

3723. Will you look at paragraph No. 2, in the second column?—"One hundred and ninety-five rounds, with shot, were fired from 0° to 24° of elevation, during which no part of the gun-breech screw or vent-piece showed any signs of weakness. There was no escape of gas, nor was there any check in the facilities of loading, during the 195 rounds, which occupied four days. A week elapsed between each day." I want to give an explanation with respect to that, because I find on the 14th January 1861 that there was a considerable escape of gas through the vent-piece, which caused the breech-screw to work somewhat hard. I remember the circumstance perfectly well, and it was this, that that gun had not been refaced after the number of rounds fired; not only during the trial that I made the report of there, but because I had a number of rounds fired after the 195 rounds. I hesitated going on with that gun, because we had not received the facing tools, and it was in consequence

quence of the gun wanting refacing that that escape of gas took place on that occasion. I have no kind of fear with respect to the escape of gas. I believe it can be made perfectly tight with common ordinary care. There has been an objection made that the gun requires skilled mechanics; but almost everything that we are using in the present day requires mechanics. The present Enfield rifle is a very mechanical contrivance compared to the old Brown Bess, and we have always got a mechanic at hand for any refacing that may be required for Armstrong guns afloat. We have the engineers in the engine-room, besides our own armourer and the blacksmith, and although people are taught to reface and use those tools, you might just as well expect a private in the cavalry to shoe his horse as to expect a common seaman gunner to handle those tools. If a weapon is worth having, it is worth having those contrivances for putting it to rights.

3724. It is stated also that there was no check in the facilities of loading?—There was not during those 195 rounds. I would have gone on firing 195 more rounds had not the pivot bolts given way in the deck and in the slide.

3725. Is there any difficulty in loading at other times?—Yes, frequently, from all sorts of causes; I could give you one cause: those men who are under instruction are not always very handy in the using of those lubricating wads, which are all experimental, having different parts of sawdust and grease; and the pulling of the sponge backwards and forwards used to bring down pieces of the burnt cartridge, and from bringing the screw too far back, this stuff used to fall in between; but when a man has been trained so as to give the necessary turn to the screw none of those things occur.

3726. I see that with the 12-pounder, on the 29th April, there was a difficulty in loading from fouling?—Yes.

3727. And on the 6th May there was also a difficulty in loading from fouling?—Yes.

3728. And on the 16th May there was a difficulty, after 20 rounds, from the breech-screw clogging?—Yes.

3729. Now, will you kindly turn to the reference to 110-pounder; on the 8th July 1861 there was also a difficulty from the screw clogging?—Yes.

3730. Do you consider that those difficulties in working the gun often arise?—They used frequently to arise; and I attribute that entirely to those experimental wads that we were trying. I always considered everything that we were doing was experimental.

3731. You stated, in answer to a question put to you by an honourable member just now, that all cases of the vent-pieces being blown out were due to carelessness. Will you kindly look at page 3 of this return, No. 6. On the 3d of December there is a case given there of a vent-piece having been blown out, and it is stated that no cause could be found for it, as the lever was as taut as it could be?—I have a perfect recollection of the circumstance to know that there was decidedly great want of attention in screwing up the breech.

3732. Do you not think that those and other cases which have been mentioned show that sufficient carelessness to cause those accidents is very likely to take place, especially in action?—One man, in an ordinary drill in the army (I saw it only 12 months ago), had his finger blown off; but he was a front-rank man, and the accident was caused by his rear-rank man, who had served through the Indian campaign in the mutiny, and had been seven years in the army. Those things will happen, do what you will.

3733. Captain Hewlett stated that the powder used for the Armstrong gun is a slower burning powder than the usual powder of the service, and it was stated by another naval officer that that made it more difficult to ascertain the accuracy of the fire, from the fact that the time was longer between the firing of the gun and the shot parting from the muzzle. Do you think that that seriously affects the accuracy of the fire?—Not the slightest. There is no doubt that the shot propelled from rifled ordnance is slower going out; but it has the advantage that the whole of the powder, or the greater portion of it, is consumed, and acts upon the shot, and tends to increase its velocity. Knowing that such is the fact, you have only got to reverse that which we did when we took to using percussion over flint locks. We always allowed a certain time for the shot to leave the bore, and it is one of the things that it was most difficult to teach the men, when the gunboat was in motion, to make that allowance. But that allowance is essential, and when you know that that is the case, it is a matter of skill, like anything else, and that skill experience alone can give us; indeed I consider it to have an advantage, inasmuch as you can always pull your trigger-line when the object is above the sight, and it is always advisable to fire with a rising motion, because you retain the sight of your object whilst the gun is coming up to it, and if you use the necessary judgment, it will enable the shot to leave the bore just at the time when it is in a proper direction.

3734. Am I right in concluding that your opinion is, that the breech-loading system of gun is by no means as yet satisfactory with respect to the vent-pieces and the breech-screw for heavy guns; do you consider them satisfactory up to the 40-pounder?—Quite satisfactory up to the 40-pounder; but I will not say that the breech-screw is any difficulty; it is simply the vent-piece; you have the strength shown you in those very diagrams of guns made at Woolwich, which are before the Committee. In those guns the breech-piece is secured by the screw plus that remaining piece of iron there. They consider that almost the same as if it were homogeneous metal; the screw has so many threads, and fits so well, that I believe it would be the last thing that will ever give way.

3735. Mr. *Beecroft.*] I think you stated that, during some part of the time that you were commander of the "Cambridge," you sent out a gunboat weekly for experimental purposes?—Yes, for general practice, and occasionally for experimental purposes.

3736. And you also stated that the Armstrong gun exhibited great accuracy?—Very great accuracy.

3737. And that also you sent it out in all kinds of weather?—Yes.

3738. Did you not find the accuracy to vary according to the roughness of the water?—Yes, decidedly; it required great skill on the part of the gunner.

3739. Those men were all undergoing continual practice?—No, they were continually changing.

3740. But were they experienced men selected for that particular purpose?—No; they were men

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under a course of instruction, and very often it was the first time they had ever fired a gun in motion like that. For experiment we always had selected experienced hands, officers or petty officers.

3741. Have the shots proved successful in rough weather on the average?—It is a difficult question to say what is an average. It would be necessary to know what the nature of the weather was.

3742. Sir *John Hay.*] What you meant to state was, that the gun was more accurate than the common service gun?—Yes, that it was more accurate; but you are liable to the very same disadvantages with that as with other guns in bad weather.

3743. In all kinds of weather you found it more precise than the common gun under the same circumstances; is that so?—Yes; there was no deficiency in the Armstrong gun in bad weather more than there would be in any other, not the least.

3744. Mr. *Beecroft.*] In rough weather in general action, would you prefer the old smooth-bore gun to the rifled gun?—Decidedly, unless it was for some especial purpose. I wish to explain by especial purpose that I allude more especially to the introduction of iron plates, which I believe, from the experiments made up to very lately (with certain exceptions which we may consider still to be experimental) have been more affected by projectiles from smooth bores than from rifled guns. Against wooden ships the rifled guns would have the advantage in accuracy of practice when the range is known, and very superior penetration at long ranges to the smooth bore, and where the chances of ricochet would be of little use from the great angle the spherical shot would rise and the loss of velocity.

3745. You spoke very favourably of the endurance of the rifled gun; was your attention ever drawn to the question whether the coils of the inner barrel ever give way?—I have never known any instance of that kind. I have heard of guns of defective manufacture, and oversight in inspection being injured; all our cast-iron guns were always proved.

3746. You did not find that the coils gave way in consequence of the firing?—I never knew of any instance of the kind.

3747. *Chairman.*] Had you any lined guns on board the "Cambridge"?—I think not.

3748. Mr. *Beecroft.*] You said that you had no means of drawing the charge of rifled cannon, but you proposed some plan for that purpose; do you think the men might be induced to draw the charge by the apparatus you described?—It would require some consideration with respect to fitting them for the percussion shell in the fuze; in fact, you cannot draw a percussion shell out of anything.

3749. You stated that the breech-loading guns were as yet an experiment; now, under those circumstances, do you think that we were justified in going to so great an expense in making so many guns before it was ascertained that that particular kind of gun was the best that could be produced?—I have stated before that it was a matter of astonishment to me when I went down to Woolwich to see the immense number of 110-pounder guns that I saw manufactured there when I felt that they were not perfect in their vent-pieces.

3750. Mr. *Dodson.*] Have you seen the French rifled gun in action or practice?—I have never seen it all.

3751. Do you know whether any considerable portion of those guns have burst?—I have heard it so stated; but I know nothing of them.

3752. Mr. *Laird.*] You said that you had had no experience of any other kind of rifled gun but the Armstrong gun?—No other.

3753. You would prefer the breech-loader if you could depend on the breech-pieces standing?—I would.

3754. Supposing that that is uncertain (as we have had evidence to show), would it do, in your opinion, for a ship to depend on an armament composed entirely of this description of gun?—Provided that no accident occurs to the men at the gun, and you had other vent-pieces, I see no objection.

3755. Do you think that it would be safe to depend in action upon them when the vent-pieces are liable to accident?—It is a curious fact that I have fired some thousands of rounds with the 100-pounder gun, and yet have seen no crack, and yet seen some cracked after a few rounds.

3756. That shows that those guns are very uncertain in action?—The vent-pieces are uncertain.

3757. That is an important part in action, is it not?—Yes.

3758. *Chairman.*] But is the consideration which you mention the only one of importance, namely, that the vent-pieces should do no harm to the men on board the ship?—I do not know of any case where they have done any harm.

3759. Captain Coles stated before this Committee that the guns were absolutely rendered unserviceable by the vent-pieces getting jammed, and that in one instance they sent up to Woolwich, when it took two days to make the gun again effective. Would not that be a serious consideration in action?—If the gun got injured, of course the use of the gun is gone.

3760. Mr. *Laird.*] They are more liable to go out of order than the old smooth-bored guns, are they not?—They are more liable to casualties, but then they have advantages.

3761. They are more difficult to work than the old description of gun, are they not?—I do not know that there is any great difficulty in working them if the men are properly instructed.

3762. It requires more skilled men?—Yes; and much more coolness and presence of mind.

3763. Therefore in action it would require a man to be very cool and collected, or some accident might occur in working the guns?—There are such very curious accidents occur with guns, that one hardly knows what to say. At the battle of Navarino, on board the "Albion," the after-gun but one on the portside was fired with six 32-lb. shot without a breeching. That I know as a fact.

3764. *Chairman.*] That only shows that in the best regulated ships the men are not always perfectly cool and collected?—Yes.

3765. Do you mean to say that you do not think there is more danger of a rifled gun going out of order in the heat of action than a smooth-bored gun?—I think not, if the men are properly looked after, and men know their business, the men will take care of themselves.

3766. With ordinary crews?—Yes; with ordinary crews, if you have proper captains of the guns. The whole thing depends on screwing up the breech-screw.

Captain James F. B. Wainwright, R.N., called in; and Examined.

3767. *Chairman.*] You are commander of the "Black Prince"?—Yes.

3768. Before you were in the "Black Prince," you were in the "Shannon," I believe?—Yes, for five months.

3769. Were there any Armstrong guns on board the "Shannon"?—Yes; I had six 40-pounders and one 110-pounder, besides boat guns.

3770. Have you any Armstrong guns on board the "Black Prince"? — Yes, in the "Black Prince" at present, I have 11 110-pounders and four 40-pounders, besides the boat-guns, which are two 20-pounders and a 12-pounder.

3771. Will you be good enough to state to the Committee your opinion of the Armstrong guns. Do you consider them safe, reliable, and effective guns for arming the navy; and will you state the facts and circumstances that have guided you to the opinion you have arrived at?—It is a gun that I should be sorry to see generally introduced into the Navy. I think, as the shell is a very formidable shell, and as the range is exceedingly great, that the gun should be used and retained on the upper deck. I dislike it on the main deck; I do not think the practice from the Armstrong gun is so accurate in bad weather as the practice from the smooth bore. On board the "Shannon," the ship rolling, perhaps, eight degrees, although the captains of the Armstrong guns were picked trained men from the "Excellent," the firing from those guns was worse than any firing I ever saw in my life; it was so bad that I stopped the fire of the Armstrong guns, thinking it was actually throwing the shot away; the ship was rolling, as far as my recollection can serve me, about eight degrees each way. On board the "Black Prince," we have fired at a target, the ship rolling to the extent of 16 degrees each way, and I consider the practice made by the smooth bore, which on board the "Black Prince," is a 68-pounder of 95 cwt., was better than the practice from the Armstrong gun. The only opportunity I had of testing one gun against another, under similar circumstances (excepting that the Armstrong gun had rather an advantage, being mounted on a higher plane on a pivot carriage), was in a trial at a range of 1,200 yards, and then the smooth-bore carried off the prize. I have a minute here of that trial. Twenty men were selected for the gun-crew, all trained men, and each gun was to fire five shots; the time was to be taken between the first shot and the fifth, and a committee of three officers gave numbers for each shot according to a scale which I laid down myself. The 110-pounder was mounted on a pivot at a height of 18 feet above the water; the 68-pounder was mounted on a rear-chock carriage at a height of about 10 feet 6 inches above the water. The 110-pounder commenced the practice, and on reloading after the first round the shot jammed in the gun; the time was therefore taken not only between the first and the fifth shot, which was six minutes and seven seconds, but between the second and the fifth shot, which was three minutes and seven seconds; there must therefore have been about two minutes fairly lost in clearing the gun. The numbers gained by that gun for five rounds were 45; the 68-pounder fired the five shots in four minutes and eight seconds, and the numbers gained by it were 57. In this trial, so long as the guns were working without accident, the time of firing each shot in the two guns was the same within a second. But I consider that the fact of this accident occurring to the 110-pounder was very much against it, because the abrasion of the lead which caused the jamming of that shot was so slight as not to have attracted the notice of any of the gun's crew. I have only seen one accident occur to a vent-piece; it took place firing a blank cartridge at night, and in that case the handle of the vent-piece of the 110-pounder upon the upper deck was shaken off and blown up, tearing the foresail just under the foreyard, and then falling back on the forecastle.

3772. On the upper deck?—Yes; it was the forecastle 110-pounder. The handle weighs about seven pounds. On the main-deck the Armstrong guns have been delayed from time to time by the vent-pieces jamming, but since that time we have returned all the 110-pounders from the "Black Prince," and have got others fitted with a new vent-piece, which I have not yet seen tried, though it is stated that it will not jam.

3773. Have you heard anything about the success of the new vent-pieces?—No, I have not.

3774. Sir *John Hay.*] Was there much motion at the time of the experiments to which you allude?—No; at that time the water was smooth. It was just below Lisbon at the exercising ground.

3775. You do not attibute any of the difference in the results to the fact of the guns being at different heights above water?—No; but I consider that the high gun had an advantage in seeing.

3776. Which it would not have had if there had been much motion?—If one gun is higher than the other, it would always have the best sight.

3777. But it would feel the motion more unless it were in smooth water, would it not?—Yes.

3778. *Chairman.*] Will you be good enough to proceed with what you have to state?—My own experience of these guns has been very limited. I only had an opportunity of firing them once in the "Shannon," and three or four times in the "Black Prince."

3779. Have you anything to say about the thickness of the smoke which has been mentioned?—We found the smoke exceedingly unpleasant on the maindeck of the "Black Prince." It is very thick indeed, and there is hardly any living there. Our ports are very much contracted, and the smoke does not very readily escape; whether it is owing to the grease in the lubricating wad, or whatever else, it is more choking than any gunpowder that I know of.

3780. Can you say whether the guns are capable of ricochet firing?—The first thing I noticed on using those guns was that the shot turned off to the right, every one of them.

3781. Can you say whether, owing to the nature of the powder employed, from the time the trigger is pulled to the time the gun goes off, there is an interval of time which has a tendency to invalidate the aim taken by the captain of the gun?—It is my opinion that it takes so long in quitting the bore that if there is much motion it must

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must affect the aim, though I am sorry to differ in opinion with Captain Jerningham. The "Black Prince" is an enormous ship, but she rolls at the rate of six times in a minute on the average; six times to starboard and six times to port.

3782. Mr. *Beecroft.*] Is that in moderate weather?—In moderate weather; and if she is rolling very deep at that rate the gun must be moving over a great many degrees in a second. I cannot imagine any experience being sufficient to enable you to take a good sight with it with much motion. The quicker the gun can get rid of its shot the better. It is of the greatest possible importance for making a good shot.

3783. *Chairman.*] Generally, from what you have observed, and from what you have picked up from other naval officers, what use do you consider ought to be made of the Armstrong guns. Do you think that they ought to be the general armament, or that there should be only a small number of them?—My opinion, and that of the majority of the officers with whom I have talked is certainly that it should not be generally adopted. I myself like them very much for distant firing; they are of very great value in throwing a very destructive shell to a very great distance; but I think they are so complicated as not to be adapted for close action. I certainly think that the very fact of a shot coming in occasionally among a gun's crew would tend to make the men a little less cool than they would be if there was nobody shooting at them, and this is a gun that requires the greatest possible coolness to work.

3784. What do you think of the fuzes?—I have seen very little of the fuzes. My opinion with respect to fuzes generally is that they ought almost always to be concussion fuzes, unless fired against exposed men. I have not seen the arrangement of the Whitworth shell for penetrating an iron ship's side; but all the shells that I have seen fired against iron plates have broken to pieces; therefore I think that shell-firing against an iron-ship is of very little use, and against wooden ships the shell ought to be fitted so as to burst immediately on striking. But experience goes to show this, that if ships are continually changing their relative distances, as they must be, it is impossible to fit the fuze in sufficient time to supply your quarters. I have tried very hard, but I have never been able to supply fitted shells at quarters, without much delay.

3785. Mr. *Beecroft.*] Are you alluding to a spherical shell, or a flat-headed shell?—Any shell; the principle is the same. You have the Armstrong concussion shell, which will explode the shell when it strikes, of course. You have to adjust the time-fuze; but it has this advantage, that it is quicker adjusted than the others when once in the shell. Of all the fuzes I ever saw, I think Colonel Boxer's is the best, simply because it takes the shortest time.

3786. *Chairman.*] Could that fuze of Colonel Boxer's be adapted to the Armstrong projectile?—No, as from the loss of windage the fuze would not catch.

3787. In the instructions issued by the Admiralty, there is one referring specially to the Armstrong guns, desiring the commanding officers to report on the flaws, is there not?—Yes, there is.

3788. Can you tell us what remarks you have made with respect to the flaws in the guns on board your ship?—On receiving that order I had the guns examined, and I discovered flaws in some of the guns; impressions were taken of those flaws, and they were sent; but after having sent an account of those flaws, I received a paper, supplied by the Inspector of Ordnance, by which those flaws appeared to have been known of before, and therefore the report of the Inspector on my letter was that the flaws had not extended since the guns were first sent to me. What I mean to say is, that at the time I sent those reports, I had not received an account from the Inspector General.

3789. Mr. *Laird.*] You have said that you approve having those Armstrong guns on board for distant firing?—Yes.

3790. But you say that, in bad weather, the guns are very inaccurate?—They are more inaccurate than the smooth-bore, I think.

3791. You have said that, even in moderate weather, your large ship rolls six times in a minute?—Yes.

3792. Therefore, as a general rule, I gather from you, you consider that you could do better work with the smooth-bore if there was any sea on than with the rifled gun?—Yes, certainly, from the very fact that you have the chance of ricochet-firing with the smooth-bore, which you have not with the Armstrong gun.

3793. Have you not had any other rifled gun tried?—No.

3794. In rapid firing in action, do you think that those rifled breech-loading guns could be worked efficiently and with safety?—I think that the rifled gun (speaking of the Armstrong gun) is more liable to accidents than the smooth-bore, and I think that any accidents occurring to a ship or the guns from any inherent fault in the construction of the gun would be of a very disastrous character to occur on board a ship.

3795. Do you mean any accidents happening to the shell from the breech-loading gun?—I mean that I consider it would have a worse effect on a ship's crew to have one of their own shells burst on deck than four of the enemy's.

3796. And the breech-loader would be liable to accidents of that kind, in your opinion?—I do not think there is much danger of explosion of that nature; the guns become disabled for the time by the blowing out of the breech-piece.

3797. And you consider the Armstrong guns more complicated than the others?—Much more so; I think they are too complicated for close action. In the "Black Prince" I put all the Armstrong guns outside the armour.

3798. And you think that the Armstrong guns are not so correct in aim at sea?—I think not.

3799. You think, also, that it would require a better class of men to work them?—Most decidedly.

3800. Is it easy in a ship's crew (supposing a vessel armed altogether with those guns) to have a class of men thoroughly instructed to work the guns?—Training to fire must always be a matter of time. There are a great many trained men now supplied to ships. On her fitting out, the "Black Prince" had, I think, about 60 men sent to her from the "Excellent;" but, as those men leave us, we are not supplied with any more; we are supposed to train the remainder of the men.

3801. Would not this rifled gun require more trained men to each gun than the common gun?—It

—It is training of a particular nature that is required for the Armstrong gun.

3802. Mr. *Beecroft.*] In general action, would you prefer the breech-loader or the muzzle-loader?—The muzzle-loader.

3803. In general action, would you prefer the old smooth-bore, or the rifle-gun?—The old smooth-bore.

3804. Mr. *Dodson.*] Which gun would you prefer for attacking a fort, or any object on dry land?—It depends on the distance. I think the Armstrong shell is, for its size, the most destructive shell that I know of.

3805. Firing against troops or against forts with a ship, which would you prefer?—If I was going to batter a fort, I would rather batter it with the 68-pounder: that was found certainly to be the best gun at the siege of Sebastopol. According to the experiments against iron-plates, the 68-pounder has a much greater effect at short range than the 110-pounder, and that, I think, is owing, in a great degree, to the 110-pounder never striking end on.

3806. Mr. *Beecroft.*] It has a greater velocity?—Yes.

3807. Mr. *Dodson.*] Had you any rifled guns in the Black sea?—I was not in the Black Sea.

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3808. Were there any rifled guns in the Black Sea?—I think not, except some Lancasters.

3809. Notwithstanding the much greater length of range of the rifle-gun, you would prefer a smooth-bore for battering forts?—Yes; because if forts are to be battered at all, they ought to be battered at close quarters.

3810. Were you in the Baltic?—No; I was in China.

3811. *Chairman.*] Taking the expenditure which has been incurred on account of Armstrong guns as nearer 3,000,000*l.* than 2,000,000*l.*, do you consider that the expenditure incurred in the introduction of the Armstrong gun into the service has been usefully incurred with respect to the armament of the Navy?—I like the gun to a certain extent; but I should be very sorry to see it generally introduced.

3812. Mr. *Beecroft.*] Do you think that we were justified in making so many of those Armstrong guns, and incurring so large an expenditure upon them, before we were satisfied by experience of their efficiency?—I should say not, as far as I have been able to judge.

Lunæ, 8° *die Junii*, 1863.

MEMBERS PRESENT:

Mr. Baring.	Mr. Laird.
Mr. Dodson.	Mr. Monsell.
Colonel Dunne.	Major O'Reilly.
Marquis of Hartington.	General Peel.
Sir John Hay.	Mr. Vivian.
Captain Jervis.	

THE RIGHT HONOURABLE WILLIAM MONSELL, IN THE CHAIR.

Sir WILLIAM GEORGE ARMSTRONG, C.B., F.R.S.; further Examined.

Sir *W. G. Armstrong*, C.B., F.R.S.

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3813. Mr. *Vivian.*] HAVE you since your last examination referred to the injuries to guns, detailed in Paper No. 8?—I have.

3814. Will you state the result of your inquiry?—The Artillery Committee refer in that paper to the general failures in the first instance, and then proceed to enumerate the failures which have taken place at Shorncliffe and Portsmouth, and in reference to the horse artillery guns at Woolwich and at Dorchester. Those I assume to be the whole of the cases that are referred to in the general words at the commencement of the Report.

3815. But is it the fact that they are the only failures?—They are the only failures that the Committee consider of sufficient importance to be noticed, I suppose. But I have prepared a statement of the whole of the guns that have been returned to Woolwich with such defects as to make it necessary that they should undergo repair in the Royal Gun Factory. The first gun mentioned in Paper No. 8, speaking of Shorncliffe, is No. 332. There were six guns returned from Shorncliffe. No. 332 was a lined gun, but though returned to Woolwich, it was free from defect. The breech-screw had three inches of the thread broken. This was removed, and filed smooth by the armourer, without the gun going to the Gun Factory; it need not have been sent to Woolwich for that purpose; it might have been rectified on the spot quite easily.

3816. What length of time in action would it have required to make that gun efficient?—If the defect had occurred in action, I do not think they would have stopped to rectify it.

3817. The breech-screw of No. 332 gun is broken also, I observe?—The breech-screw is broken. That would have been rectified at once by using the spare breech-screw; but the broken thread could have been cut off almost on the moment with hammer and chisel. It was very easily done. It would have been very easy to remove the loose piece.

3818. Will you now take the next case?—That is No. 198; that was also a lined gun. The injuries are correctly described. There is no doubt that the gun was completely disabled. The injuries are described thus: "The part of the gun behind the trunnions was drawn away from the rest of the gun half an inch, and carrying away with it the bouche of the gun 6-10ths of an inch." The gun, of course, did not burst. They might have gone on firing for a certain number of rounds; but if they had done so, the gun would very speedily have become wholly unserviceable.

3819. Did you attribute that injury to the lining of the gun?—Yes, decidedly.

3820. Was the lining imperfectly done, or was the accident the result of a cause inherent in the lining?—It is the effect of the lining in general to weaken the gun at that particular point; but in this case, I imagine, the lining had not been very tightly inserted; if it had been tightly inserted, it would have contributed to the strength of the gun very much to the same extent as a solid tube would have done.

3821. The injury is an injury more or less liable to occur to any lined gun, I suppose?—Yes, I think so; but a great deal depends on how the lining is inserted.

3822. The next gun is No. 190?—Yes; that is also a lined gun. It was returned on account of the lining having crept forward to the extent of 14-100ths of an inch, which did not render the gun unserviceable, and it could be repaired at a cost of 30*s.* in the Royal Gun Factory.

3823. Major *O'Reilly.*] How was it repaired?—That I cannot say; but I imagine the lining would be replaced; the external part would probably be reheated, and the lining pressed back again. The gun returned from Shoeburyness was repaired at a cost of 30*s.*, and this could be repaired at the same cost.

3824. Mr. *Vivian.*] That injury seems to have occurred after 34 rounds; is not that a very small number of rounds to be followed by such an accident?—Certainly it was; the bouche must have been very loose. The gun which was similarly affected at Shoeburyness crept forward very slowly; and long after it had moved to the extent of 1-10th of an inch, they continued firing it without any bad effect. This gun, if it did not move more quickly, might have been used for a length of time.

3825. But

3825. But a corresponding vacancy occurred behind the piece that crept forward?—That only occurred against the copper bouche, against which the vent-piece tightens; it was screwed into the solid part of the gun, but that vacancy was quite harmless.

3826. Supposing accidents like this to occur on foreign service, could they be readily remedied?—They could not be readily remedied on foreign service.

3827. In action could they be readily remedied?—In action they would go on using the gun.

3828. The next gun is No. 287?—Yes; No. 287. The injury to that gun is thus described: "Seventeen rounds were fired from this gun, when it was considered unsafe, from a long crack in the coil behind the trunnions." That is simply a badly manufactured gun. The metal had probably been bad, and the manufacture had been defective. The only thing that can be urged in respect of that defect is that the gun was a very early one. I do not speak in vague terms, because I can give you the precise date of its being proved. It was proved in April 1860. Now the Royal Gun Factory commenced manufacturing about the beginning of August 1859. The erection of the plant commenced in March 1859, and there was no iron in the place at all to make the guns till July 1859; therefore it is not conceivable that there would be any coils or parts of guns manufactured before August 1859. Now this gun was proved in April 1860, which I think, is eight months afterwards, but then the parts composing that gun would be made several months before that, because the time occupied in advancing from the state of mere rough forgings to the finished form of the gun is a period of several months, and therefore it is certain that those coils would be manufactured within four months after the commencement of the operations in the Royal Gun Factory, and it is quite possible that it might be still nearer the commencement. Now at that period we were labouring under very great disadvantages; we had had very imperfect experience; we did not understand what was the most favourable kind of material, and we did not understand the best mode of dealing with it, so that the guns were necessarily subject to defects of this kind.

3829. This crack must have extended across the grain of the iron, must it not?—Yes; across the grain.

3830. Could that have been from a defect in the welding?—No, not from defective welding; I think it must have been defective iron; probably it was overheated. The next, I think, is gun No. 315. The injuries are thus described: "About 170 rounds were fired, when a large flaw was observed in the bore, about 18 inches from the muzzle; 30 more rounds were fired, the flaw increasing each round. The shells were checked by the flaw in their passage through the bore, and in many instances they burst in consequence." Now that gun was returned to Woolwich, and it was found on examination that the flaw merely required filing level, so as to remove a projection, and that was done in the Royal Gun Factory at a cost of 6*s.*, after which the gun was returned as serviceable, and is now either returned to the batteries, or is at all events ready for issue.

3831. Then the flaw was in the nature of a riff I presume?—Exactly; that was one of the greatest difficulties that we experienced in the first instance; by using improper iron we got blisters, and those blisters were liable to be rucked up so as to form a ridge on the gun; but when the ridge was filed down, the mere cavity was found to do no harm at all, the shot riding over it.

3832. The flaw was not in the nature of a crack, but in the nature of a fold in the iron?—Yes; a blister.

3833. The next gun is No. 160?—Yes. The injuries to gun No. 160 are thus described: "This gun was fired about 200 rounds. Several cracks have appeared on the exterior running round the piece. These increased in size with the number of rounds. In washing this gun, water finds its way through the largest of these cracks." That again is another case of a gun that has been badly manufactured; the welds were quite defective. I find that the gun was proved in February 1860; that was between six and seven months of the commencement of the manufacture in the Royal Gun Factory, and the probability is that the coils of which that gun was made were amongst the very first of all those that were manufactured. They must have been very early indeed, and possibly amongst the very first. I may mention here that the number of the gun does not indicate the order in which it is made, because I find in one instance where the gun is numbered 321, it was in point of order in the manufacture the seventh gun; therefore the only criterion is the date of proof.

3834. At what point in the manufacture of the guns at the Royal Arsenal did those failures probably cease?—I think they are almost entirely confined to the 12-pounders, which were the first guns made, and probably the first half of them. I think that after we were in operation eight or nine months, all those defects would be surmounted in a great degree, but the improvement has been progressive all the way through, as might have been expected. That finishes the Shorncliffe guns.

3835. With regard to those guns I would ask whether any of those which were tried, proved altogether satisfactory and without injury?—I have only this report upon the subject. I cannot say.

3836. It appears that six guns were tried?—Six were returned as defective.

3837. Can you tell the Committee what number of guns were tried at Shorncliffe altogether?—In this particular instance, 12.

3838. So that six guns out of 12 proved defective?—No, five guns; because one of them was found not to be defective at all, except in the breech-screw.

3839. Five out of 12 were proved defective?—Five out of 12 were defective; but of those five, only three required extensive repair, namely, numbers 287, 198, and 160. One is not unserviceable, though requiring repair; another need not have been returned at all, as it only required filing. There were six guns returned; five of them were defective; three required extensive repair; one was not unserviceable; and of the remaining two, one was not defective; and the other only required to be filed smooth.

3840. Will you now proceed to the further trials of the I and K battery?—Yes, to the Portsmouth guns; now before the commencement of those experiments, six guns out of 12 were withdrawn, four of them as being lined guns; because the previous experiments had thrown suspicion on lined guns, the intention being at that time to withdraw

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withdraw all lined guns; two others were also withdrawn as showing flaws. Now three out of those six guns were afterwards subjected to a course of additional proof at Woolwich, and they have all been returned as serviceable without repair. In three out of six, therefore, there was no occasion to withdraw those guns at all.

3841. What was the nature of the trial?—It was continued firing, with developing rounds (that is to say, with charges equal to one and a-half times the service-charge) to a sufficient extent to satisfy the Inspector of Artillery, that they were perfectly trustworthy. Then number 316 was serviceable when returned; but, under the course of 10 developing rounds, the lining split; the two others were passed as serviceable, without any additional proof or repair at all; so that there was only one gun out of six that yielded to the additional test. Now as it happened, three out of the six guns sent to replace those guns which were returned, were also lined guns; and they were, therefore, in the same state as those guns that were withdrawn.

3842–3. Who selected those guns?—I think they were not selected; I think they were merely taken out of the stores; but that I do not know; in fact, we must assume there was no selection; for if there had been a selection, the lined guns would have been avoided. Then there is the question whether another of the six substituted guns was not also lined, though there is no doubt whatever as to three of them; because I have referred to the records of the Royal Gun Factory, and I find that three are unquestionably lined guns.

3844. Would it not be practicable to mark at once upon a gun the history of its manufacture, whether lined or otherwise?—Quite.

3845. Would it not, in your opinion, be desirable to do so?—Yes, I think it would. It does not, therefore, appear that any material advantage was gained by changing those guns. In fact, except in the case of the one which yielded to the proof charges, and which we have no right to assume would have yielded to service charges, there is no superiority in the guns that were sent down to replace those withdrawn.

3846. Did not some correspondence occur with respect to the withdrawal of those six guns before the experiments?—I was not privy to it; but I suppose there was some correspondence. Then the report proceeds to state that three of the guns used in those experiments showed signs of injury, two of which were of a serious nature. Now the two guns said to be seriously injured were Nos. 153 and 250. No. 153 was the gun in which the steel vent-piece broke and caused the injury to the screw. That gun was found only to require filing by the regimental armourer, and it was not sent to the Royal Gun Factory at all. The filing could easily have been done on the spot. It was merely a little burr, so the injury was not serious at all; it might have been rectified in the very heat of action. No. 250 is said to have exhibited two flaws, through which the fouling passed during practice. Now, that must have been a mistake, for the gun was proved with five developing charges, and also by hydraulic pressure, and neither fouling nor water passed. The gun, therefore, is passed as serviceable, and requires no repairs at all; so that I am correct in stating that in that experiment none of the guns had suffered any serious injury.—I will now pass on to the horse artillery guns. The report proceeds to observe:—"The injuries in question are generally of a trivial nature, and resulting from the premature explosion of the shells in the bores. The necessary repairs can be effected by the battery armourers. In two of the guns examined, there are small openings of the coils, and as these openings have increased with the number of rounds fired, it is recommended that these two guns be submitted to a careful examination in the department of the Inspector of Artillery." Now, there has always been a great tendency, and a very natural one, in officers who have not much familiarity with these guns to attach undue importance to any apparent defects in the bores. Those defects are almost invariably called partial openings of the coils; but they are not at all of that nature; they are, generally speaking, merely *striæ* in the iron, or mere marks of the weldings that take place, and not real openings at all. Perhaps the Committee would like to hear the opinion of the Ordnance Select Committee upon defects of that nature, because complaints are very frequently made. Officers send in reports, stating that there are certain marks found in the guns, indicating a separation of the coils, and the Ordnance Select Committee, before whom all complaints of that kind are placed, observe upon that subject:—"The Committee are fully of opinion that in the majority of cases, if not in all, the slight appearances returned as flaws or openings of coils are of the most harmless character, perfectly distinct from fissures of metal. The fact that they are reported in four guns which have only fired blank ammunition is almost a proof of this, for it is impossible to suppose that a gun which has passed proof can be injured by blank ammunition. Many of these supposed flaws are reported not to have increased in subsequent practice. With respect to No. 26 gun, considered unsafe, the Committee think it of such consequence to establish confidence in the real strength of these guns, that they recommend that it be tested to destruction." Now No. 26 is the very gun which is mentioned here. I have only to observe further that the small openings were of no importance at all, and did not really constitute any defects. All those guns, it appears, have been returned into store without its being found necessary to subject them to any further proof or repair, or anything else. The particular gun, No. 26, which is dealt with here, is a 9-pounder horse artillery gun, and is a solitary instance of a defective 9-pounder. It appears to have been imperfectly welded at three inches from the muzzle, but it is not proved to be unserviceable, and I think it would very likely be capable of bearing any amount of firing. It is merely a suspicious case very near the muzzle of the gun, which may be found of no consequence; no failure has taken place in it as yet. The report proceeds to notice the experimental practice of a hundred rounds with two batteries of nine-pounders at Dublin, and pronounces it highly satisfactory. Those nine-pounders are furnished with all the improvements which our experience has enabled us to adopt. Then comes the case of the explosion of a concussion fuze in a limber box, which seems to be sufficiently explained, and there is nothing that I can add to what is stated in the report. They also mention the practice with the 110-pounder, in which the recoil was said to be excessive, and which you have already heard explained.

3847. Would you have the kindness to refer to paper 42 of the Appendix, in which this passage occurs:—"Three guns only have been used for instruction

instruction practice. The remaining three have not been fired since their arrival at Kirkee, yet these three all show transverse marks, also flaws, as noted in the proceedings of the Board of Survey, dated 5th December 1862." Do you attach any importance to that?—No, not at all; I believe that they are precisely of the same character as those defects which are so frequently complained of.

3848. Will you kindly read the passage which follows?—"The three that have been in use also showed these transverse marks previous to being fired. Though these three guns fired about 112 rounds respectively, it was not till the fracture of the inner coil, close to the muzzle of one of them, occurred, any fear was entertained that any of the transverse marks were more than skin deep. I would particularly bring to notice, that these transverse marks across the rifling existed, not in one particular gun, but in every gun composing this Armstrong battery."

3849. It appears that one gun did fracture in the inner coil?—Yes; very nearly at the muzzle; and there is a report of the Ordnance Select Committee on that subject.

3850. There was a report of the proceedings of a Board, assembled at Kirkee, on those guns?—Yes; the whole of the papers seem to have been referred to the Ordnance Select Committee; and they have made their report upon them.

3851. The Committee assembled at Kirkee enumerate certain failures which occurred in those guns: "No. 59, weight 8 cwt. 2 qrs. 19 lbs.; Elswick Ordnance Company, 1860; inner coil projecting one-third of an inch at the muzzle"?—I think we had better see what the Ordnance Select Committee say about it; because the Committee are much more competent to speak about it than I am.

3852. They say "the other so-called cracks appear to be of the kind which is incidental to all built-up guns of the earlier manufacture, and to arise from imperfect welds or superficial welds alone"?—Yes. "The Committee have the honour to report that, on carefully perusing the report of the Board of Survey, held at Kirkee, 9th December 1862, they are led to the conclusion that none of the flaws reported to have been discovered in the 12-pounder guns, are of any consequence, except that in gun No. 59, which will be removed by cutting off the muzzle, and reducing the length of the gun by four inches. As it has been shown that the land service 12-pounder may be reduced to the length of the sea service 12-pounder without sensible loss of range or accuracy, and measures are actually in progress for carrying out this reduction, the Committee see no objection, as a temporary measure, to the shortening of No. 59 by four inches. The other so-called cracks appear to be of the kind which is incidental to all built-up coil guns of the earlier manufacture, and to arise from imperfect welds or superficial flaws alone. They are of a very different character from fractures of the metal, and with the exception of the slight flaw reported to exist in No. 53, at eight inches from the muzzle, which will also be cut off, should these guns be hereafter reduced in length, they were all noted by the Inspector of Artillery before the guns were issued; a proof, at least, that, in the opinion of that department, they were of no practical importance. It is natural that officers accustomed to look with alarm at any fissures in a cast-iron gun should at first extend the same suspicion to every appearance of a fissure in a wrought-iron one, but the Committee would point out that the circumferential strength of the gun is not affected by imperfect junction of coils."

3853. But a little lower down in the report you will find this occurs:—"In another instance a few inches of the muzzle of a 20-pounder were blown off, which was undoubtedly due to an original flaw, or a bad weld"?—Yes; that was in some experimental practice at Shoeburyness: "In one instance a few inches of the muzzle of a 40-pounder were blown off, which was traced to a drill shot having been left in the gun. In another instance a few inches of the muzzle of a 20-pounder were blown off, which was undoubtedly due to an original flaw or a bad weld." That was noted before the gun was sent down, and it was perfectly understood that that flaw existed. We knew it was the case.

3854. Do you consider that your system of manufacture will always be liable to injuries of this character?—I think it is almost entirely exempt from that liability now, and I believe has been so for some time past; the original guns were certainly subject to it.

3855. Is it possible so to weld iron in all cases as to secure its being exempt from flaws?—By very careful inspection and testing you are enabled to reject nearly all the barrels that are defective. We have much more stringent means of testing them now than we had at first. We now understand the iron that is suitable for welding, and the mode of treating it, so that these cases are reduced to a very small number. At the same time I very much prefer, for the barrel, a material like steel, in which such defects cannot exist. My only objection is, of course, the uncertainty that has hitherto attended its manufacture.

3856. Supposing that steel could be softened to the same extent as wrought iron, you would prefer steel; is that so?—If it were uniform, that is the difficulty.

3857. The weld in wrought iron is always a point of weakness, is it not?—It is weaker; but in the coil arrangement, the weakness, being transverse to the bore, is not of much consequence; if it was longitudinal to the bore, it would be very serious.

3858. Have you given your attention at all to the recent experiments that have been made with steel; the long annealing?—I have no faith at all in annealing; not the least. I think it is injurious to the steel.

3859. You think also that a lengthened cooling is injurious to the steel?—I do not think that there is much attributable to slow or quick cooling. I do not think that the quality is very much affected by the rate of cooling. So far as annealing is concerned, my experience is that the quality of the material is actually deteriorated. The effect is to cause a gradual deposit of the carbon. The steel, after being exposed to a very lengthened annealing, is found to be full of charcoal; and if you examine it with a microscope, the carbon is found to be actually deposited between the crystals.

3860. What length of annealing have you in your mind?—Two or three weeks; but that deterioration goes on from the first.

3861. But if the carbon could be disengaged from the iron, the iron would then become wrought-iron?—Yes; but of a very imperfect character, crystalline wrought-iron, which would be about the very worst material that you could have.

3862. Shortened guns are not so accurate as

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guns of the proper length, are they?—I think there is a very little difference in that respect; but before we go to a new subject, you will, perhaps, allow me to complete my statement with respect to the defective guns. I have here a complete statement of all injuries occurring to guns of all natures, which have been of sufficient importance to require the guns to be returned to the gun factory. The first table comprises 14 cases; the first in my list is a nine-pounder, the Dorchester gun, which is the only nine-pounder which has been returned to the gun factory for repair. The number of nine-pounders issued and in use is 66. That gun, as I have already described, has an external crack at some three inches from the muzzle; it is extremely doubtful whether it is a crack of any importance, but very properly it is returned to the gun factory for repair, and will be repaired; if it was on service, I have no doubt the gun would be used, probably, for any length of time. The list then applies to the 12 pounders, of which there are 13. This includes all the Shorncliffe guns, and all the guns that have been returned from Shoeburyness; in fact, the whole of the guns that have been returned to Woolwich requiring repair. There are just 13 of them altogether. The nature of the defects and the cost of repairs, so far as I can ascertain them, are also stated; out of those 13, there are two that have been repaired at a cost of 11*s.* 6*d.* for the two. Now, those two guns had similar flaws to what I have already described; they merely required filing smooth, and that might have been effected quite well by the battery armourers, and will be effected by them now that they better understand the duty; so that, leaving out those two, there are only 11 that require to be dealt with.

3863. Out of what number issued for the service?—The number of 12-pounders issued for the land-service is 392, and for the sea-service 178; to them I have to add the 66 nine-pounders, which make altogether 636. Out of those 636 12-pounders issued, and in use, only 13 have been returned to Woolwich for repair; and out of those 13, two were repaired at a cost of 11*s.* 6*d.*; of the remaining 11, we had seven guns that were returned as defective, in consequence of being lined, so that if we had not unfortunately adopted this mistake of lining defective guns, we should only have had, out of 636 guns, four guns returned to Woolwich for repair.

3864. Is No. 250 one of the guns that would have been returned?—It is not in my list of returned guns.

3865. It is mentioned in Appendix No. 8 as one of the guns in which the fouling had come through, is it not?—That must be a mistake, as I have already shown; there had been some little sweating, or something of that kind. Now the number of rounds fired from those guns cannot, I believe, be much short of 50,000 rounds; in fact, it would be more. At Shoeburyness alone, we had 22,000, while we had in China about 4,000, making 26,000. We had, again, in the experimental firing with entire batteries upwards of 4,000 rounds; that brings up the number to 30,000; and then we had all the ammunition issued for experimental practice with the batteries, which is 50 rounds per gun per year, some of those guns having been upwards of two years in the service, so that 50 rounds each upon the 636 guns would be 30,000 rounds. The result is, in all, 60,000; but I will call it 50,000. so that those casualties, to which I have been referring, occurred in the history of 50,000 rounds fired from 636 guns.

3866. So far as the gun itself is concerned, you mean?—So far as the gun itself is concerned.

3867. But not so far as the parts of the gun go?—No. I have already stated the amount of casualties upon the vent-pieces, and I can now speak of the screw. I gave a return of the number of vent-pieces at the last sitting of the Committee, and stated that the total number broken in the 12-pounders was 19, but I think I should have said 20, because I cannot distinctly make out whether the steel vent-piece that broke at Hilsea is included or not, but probably it is not, so that I ought to have said 20 instead of 19. Those guns that have been returned, with one exception, are all specimens of the early manufacture. I have the dates of the proof of every one of them, and I find that, with the exception of No. 341, which was proved in January 1861, all the other guns were made within the first six or seven months of the commencement of the manufacture, at a period when it was quite to be expected that we should meet with difficulties of that kind, and therefore it does appear to me that, so far as the 12-pounders are concerned, anything has occurred but what might have been reasonably expected in introducing so novel a system of manufacture on so extensive a scale.

3868. Can you state whether similar experiments have been made on guns recently manufactured?—The guns recently manufactured are in constant use, and are issued indiscriminately with the others. There are many of them at Shoeburyness, and we have not had those defects occur with the new guns, at all events it is very rare. There is one new 40-pounder only which has failed.

3869. Can you state the number of recent 12-pounders which have been issued, and fired for a number of successive rounds without exhibiting those flaws?—No; because they are so mixed up with others. But when I state the large number that have been issued, and the enormous amount of firing that has taken place, and the small percentage of casualties, I have shown quite sufficient to establish the soundness of the system of manufacture, and to exonerate the Royal Gun Factory from any culpability. I will now proceed to speak of the screw. Twenty-two screws have failed, not absolutely failed, but the front part of the thread has cracked at the root, and requires to be cut off. It is owing to a defect of construction. That was a form of screw that was adopted under a mistaken idea of the relative strength of steel and wrought iron; but the defect is entirely confined to that particular form of screw in the 12-pounder. I find in the case of the 110-pounder that there has not been a single case of the screw failing from that cause, or any other cause. In the case of the 40-pounder there have been none; in the case of the 20-pounder, none; and in the case of the 9-pounder, none. It is entirely confined to the 12-pounder. The whole number that have so failed is 22. Those 22 are the cases of screws which have been returned, but there are, no doubt, many guns in the batteries which have a portion of the front thread broken, which has been cut off by a chisel, the gun remaining quite serviceable, Now, the Ordnance Select Committee, in reporting upon the diaries of the officers for the last half of the past year, state with respect to those defects in screws:—"In the majority of cases, the complaint is that a portion of the thread

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of the breech-screw is broken. The Committee have frequently pointed out that there are more than 10 feet of thread on the screw, and that the loss of many inches does not sensibly impair its holding power. The liability to this accident can apparently only be met by putting new screws with bevelled threads into all the guns. In the case of No. 332, H battery, 9th Brigade, where it is said that it takes two men to work the screw, there is evidently a portion of the thread sprung which ought to be cut off." That, I think, is all I have to say on the subject of the screws. I will now go to the 20-pounders. Of the 20-pounders there has only been one gun returned to Woolwich for repair, which is also a lined gun, and of which the lining is split. Then with respect to the 40-pounders. The number issued is 641, and there have been nine guns returned. Of that number four of the guns, that is to say, four of the nine guns returned, have been repaired at a cost of 3*l.* 11*s.* 8*d.*; that is 12*s.* or 15*s.* a piece. Now it turns out that the defects of those guns are exactly of the same nature as in the case of the 12-pounders, namely mere roughnesses in the gun, which only require a file attached to a long stick to remove them. That could have been done quite well upon the spot, and is now invariably so done by the battery armourer.

3870. With respect to the 40-pounders, will you refer to the Blue Book of the Committee of the last Session, at pages 219 and 237, where you will find that 192 40-pounders had been issued up to March, 1862, and that 153 of those guns had been lapped out, and various other repairs had been done at a cost in all of 4,054*l.*?—Yes; but that is for work done before the guns were issued; repairs before the proof; lapping out simply means grinding out the bore.

3871. It seems that there were 40 guns supplied with two vents per gun, 504*l.*; 21 guns bouched throughout, 740*l.* 5*s.*; 25 guns bouched with bouches of various lengths, &c., 250*l.* 10*s.* 6*d.*; 20 guns fitted with breech coppers, failed at proof, 11*l.*; repairs to guns found defective at proof, which comprises every kind of repair not specifically mentioned in any of the foregoing, and is applicable to the whole number of 40-pounder guns delivered, 1,325*l.* 16*s.* 8*d.* In hand at present, 1,055*l.* Total, 4,054*l.* 18*s.* 2*d.*?—Those repairs were, of course, before the guns were issued. Those are questions of manufacture, and not of repair.

3872. It appears that those guns were delivered by the Elswick Ordnance Company to the Government, and I presume that they were complete and ready for use; and that, subsequently, those guns had the additional repairs done, after proof?—I suppose it had been a question, whether those guns should be returned to the Elswick Ordnance Company, or to the Royal Gun Factory. But then repairs before issue are repairs belonging to the manufacture, and have nothing to do with the subsequent failure of the gun; the gun is not in a state for issue till those repairs or alterations have been made.

3873. But the Elswick Ordnance Company delivered the guns complete to the Government, did not they?—I do not know at all what the case is. As it stands here, it simply appears that there is a certain amount of expense incurred; I do not know who has paid that expense, or anything else about it; all I can say is that those are expenses appertaining to the manufacture of the gun; because, until the gun has been passed, it must be considered as in a state of manufacture.

3874. Those repairs were rendered necessary by defects which showed themselves, probably, on proof?—Perhaps that may be so; but I cannot give any information about them. I am quite ignorant of the matter; but I have been speaking previously of guns that have been found to require repair, after being issued for the service. The alterations referred to in this account are all before final proof.

3875. On 192 guns delivered from Elswick, 4,000*l.* required to be expended after proof?—After proof; not after the final proof.

3876. The guns were found defective at proof?—Yes; but guns are very often found defective at proof.

3877. Major *O'Reilly.*] Can you say if this 4,000*l.* was expended after payment for the guns?—I do not know, but it is not at all likely, I think. I can get an explanation of it from the Elswick Ordnance Company without any difficulty, but it was not in my department at all.

3878. Captain *Jervis.*] No guns are paid for till they are accepted and marked?—That is the rule.

3879. Mr. *Vivian.*] My question referred not to the question of payment, but to the question of the failure which may arise on the 40-pounder gun, inasmuch as 192 40-pounders required these repairs?—No doubt. In the early stage of the manufacture we had a great many defective barrels which required repair after first proof, but the repairs I have been speaking of are those required after the guns were issued, and those which I mention are all that I can get intelligence of. Out of 641 guns nine have been returned to Woolwich for repair, and of those nine guns four have only required levelling in the bore, which has been done at a cost of 3*l.* 11*s.* 8*d.* The remaining four guns required extensive repairs; but one of those failures occurred after 671 rounds. That is all I have to say with respect to the 40-pounder. There is only one failure to a new pattern gun. Then with respect to the 110-pounders, the number issued is 799, and the number returned to Woolwich for repair is nine. Of those nine guns I find that six required repair in consequence of having been made with solid forged barrels instead of coiled tubes, the result of which has been that they have fissured longitudinally to an extent which became alarming, and it has been necessary to substitute coiled tubes for those forged tubes. I can give you the particulars of the injuries if the Committee wish it.

3880. The only failures of 110-pounders I think which are laid before this Committee are in Appendix No. 11, page 2, "Three 110-pounders failed in proving the vent pieces?"—That is a separate question altogether.

3881. Will you state to the Committee the way in which the guns failed?—In proving the vent-pieces, the gun is fired each time with a double charge of 27½ lbs. of powder, which is of course an excessively severe strain upon the gun, and the number which have failed in the proving of the vent-pieces is eight.

3882. Out of how many used for proving the vent-pieces?—They continued to use them till they failed, and in some cases they have stood as many as 357 proof rounds with double charges, which is a most extraordinary amount of endurance; one gun which had been previously fired 100 rounds with shot rising up to 100 lbs., one

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gun has stood 319 proof rounds, another 247 proof rounds, another 357 proof rounds, another 261 proof rounds, another 119 proof rounds, and one only 27 proof rounds. Of course that was a very inferior gun, but still even 27 proof rounds is a very severe test. Another one has borne 15 proof rounds, but that was a bad cracked gun at the commencement; that was known, and it was taken for the purpose of ascertaining what endurance a cracked gun really had, and it bore 15 double proof rounds; then with 40-pounders the failures in proving the vent-pieces have been five. One gun has actually stood 1,050 double proof rounds; another 460 double proof rounds, another 369 double proof rounds, another 144 double proof rounds, and the least of all 135 double proof rounds. In the case of the 9-pounders, the 12-pounders, and the 20-pounders, there has been no failure in the proof rounds. In the six-pounders there has been one failure (No. 9); but the six-pounder is an extremely light gun, it is made purposely so light as to be carried on a horse or a mule, and has not the same margin of strength that the other guns have. That is a complete statement of the guns of all nature that have failed in the proving of the vent-pieces.

3883. You have not given us, I think, a statement of the 110-pounder guns that have been returned from the service?—Yes; I said that nine have been returned, and five of those cases were on account of defects incident to the use of solid forged barrels instead of coiled barrels.

[*The Witness handed in a statement.*]

3884. *Chairman.*] Were the repairs referred to in this paper made at Woolwich?—They were made at Woolwich. I also hand in a return of the number of guns that have been issued. Now I should wish to observe while on this subject, that it is necessary to impress upon the Committee the necessity of considering those failures in connexion with the number of guns that have been issued, and also with the extent of the practice with them, because after all, the question is what percentage of failures occur. Of course if the Committee dwell on a few isolated cases of failure, and do not take into consideration the extent of the successful practice with those guns, it is very easy to form an erroneous estimate of the importance of the failures. I may state also that all the officers who have had the largest experience with these guns, including those who had the direction of them in China, are almost unanimons in their approval of them. It has been said that the favourable opinion of the gun has been reversed by the failures at Shorncliffe and elsewhere, but I would point out that His Royal Highness the Commander-in-Chief and Colonel Bingham, who were the two distinguished officers whose confidence it appears had been especially shaken, have each declared before this Committee after a thorough investigation of the whole case, that the British service has the most efficient system of field artillery in the world. Some individual guns have borne some thousands of rounds without injury, and others have resisted the utmost efforts to effect their destruction. I think that is all I have to say on the subject of failures and defects.

3885. *Chairman.*] Will you kindly state with respect to the experimental guns how many of each sort had been ordered and made, taking first the 300-pounder muzzle-loading gun?—I cannot do so off-hand. Of the 300-pounder, I think that 10 were ordered of the Elswick Company, and four at Woolwich.

3886. And how many of the 100-pounders on the wedge, or side-loading principle?—One hundred.

3887. Is not there a 600-pounder now?—Only one.

3888. Are there any others that may be called guns under trial besides those?—There is the naval broadside-gun.

3889. Of that, how many are included?—One.

3890. What is the size?—It has a $9\frac{1}{4}$ inch bore. I call it a $6\frac{1}{2}$ ton gun, or a 150-pounder, speaking by the weight of the shot.

3891. Sir *John Hay.*] You are specially limited with respect to the weight of that gun, are you not?—Yes.

3892. Mr. *Vivian.*] I think you have said that the lead is not now liable to strip off the shot?—No, it is not; and I do not think the liability has ever existed to a great extent.

3893. Will you kindly turn to No. 6 of the Appendix of this year, pages 9, 19, 11, "the 7th and 10th shot stripped." That is in February, 1863.—The 1st, 3d, 4th, 7th, 11th, 13th, 14th, 16th, and 21st shot did not explode; the 7th and 10th shot stripped. It does sometimes occur, that is to say, with the lead attached by the old method, but it never occurs now, and it was rare even then.

3894. Do you imagine that that result was owing to the shot being of the old pattern?—Unquestionably.

3895. Sir *John Hay.*] Have there been any recent complaints from the Navy, and especially from the "Doris," with respect to the shells stripping?—There were some shells returned on the ground that the lead was loose.

3896. Can you state the nature and the cause of that defect?—I do not know of any complaint of the lead stripping, but there was a complaint that a certain number of shells appeared to have the lead imperfectly attached, and that the lead was hollow. Those shells were in consequence returned to Woolwich, and the Ordnance Select Committee ordered them to be fired at Shoeburyness, under circumstances that would show whether, even where the lead was loose, it would be liable to be detached; and the result was that the whole of the defective shells were all fired through a hole in a screen, and some two or three ounces of lead came off, the whole weight of the lead being something like six cwt. or seven cwt.

3897. And the shells are still fit for the service?—The shells were quite fit for the service.

3898. There is no other record of any recent occurrence with respect to the stripping of the lead, or its insufficient attachment?—Nothing that I know of.

3899. Colonel *Dunne.*] Is there any complaint of a corrosion of the lead occuring in the shells; that by some chemical action the lead gets deteriorated?—It has been argued that there was such a deterioration going on, but never substantiated. My own opinion is, that there is none; but even if there was, the manner in which the lead is attached by the mechanical mode makes it perfectly independent; I am satisfied that there is nothing in the objection at all.

3900. Major *O'Reilly.*] Something has been mentioned with respect to vent-pieces being made in what is called a sandwich manner, have you used such vent-pieces?—Only experimentally.

3901. You do not call that one of the "changes" in

in the manufacture of the vent-pieces?—No, that has never been introduced. That was the adoption of alternate layers of steel and iron, and it did not answer. By far the most satisfactory thing (though it is not yet fully carried out, and I do not express complete confidence in it) is using steel toughened in oil, a plan which has been occupying my attention for four or five months past. I expect that we shall entirely surmount the defect of the 100-pounder by that plan.

3902. I understand you to state that you have tried many experiments and many materials to obtain a perfect vent-piece besides those enumerated in Appendex No. 49?—Yes, certainly; I have been continually experimenting.

3903. Mr. *Vivian.*] With respect to the fuzes, can you state to the Committee why and under what circumstance the fuze was originally adopted which has been now condemned?—There was no alternative. Are you speaking of the time fuze?

3904. Will you kindly turn to No. 15 of the new Appendix, at the bottom of page 6, and read the last paragraph to the Committee?—"The Committee do not find that the fuze was specifically submitted for approval to the War Office before November 1858, when the first special Committee on rifled cannon included a drawing of it in their Report to Major General Peel, nor can they find precise particulars of practice with it earlier than September of that year; but from allusions in Colonel Mitchell's report, of 9th February 1858, it was evidently in use at that date; so much was at that period left to be worked out by Sir William Armstrong and Colonel Mitchell, in private trials, that the official records are very incomplete."

3905. Will you also read the next paragraph?—"In this way, without specific approval, or apparently much discussion of its fitness for general service, Sir William Armstrong's time fuze came to be treated as a part of his system; the batteries sent to China were equipped with it, and it was virtually in the service when the present Ordnance Select Committee received, for the first time, from the War Office (18 February 1860), for their consideration and report, drawings of this fuze as a part of the ammunition of the 12-pounder gun."

3906. Is that statement on the part of the Committee correct in regard to the adoption of the fuze?—I can only say that both the time fuze and the concussion fuze were submitted by me, along with the gun, for general approval at the War Office, and they were adopted.

3907. Those are the fuzes which are now condemned?—They have been improved upon.

3908. They are the time fuzes which have turned out defective?—Yes.

3909. Do you consider that it would be safe to permit those fuzes to continue a portion of the armament of the British Army, I mean with respect to their efficiency?—The simple question is, which is the most efficient fuze that can be obtained. Now the new pattern is more efficient than the old, therefore I presume that it ought to be substituted; and a new substitution cannot be effected without certain sacrifice of material.

3910. The Committee seem to speak very decidedly upon the question in recommending their withdrawal?—Because there is a better form of fuze to be had.

3911. Will you turn to No. 15, page 6, where the Committee say the old pattern fuzes that were at one time considered perfection are now very faulty, and should be withdrawn at once?—Yes; they had suffered deterioration by keeping.

3912. The consequence is that those fuzes are a dead loss?—If they are rejected they are, but they are by no means unserviceable; they are inferior to what has been since produced, and that is all that can be said about the matter; but I should like you to refer to the second Report on the subject in No. 39, by which it will be seen that they are not a dead loss. "The Deputy Adjutant General is informed that the Secretary of State has decided that the ammunition in possession of the Field Artillery is to be used up at the ordinary practice of the batteries, but that care must be taken that the proportion laid down by the regulations are not exceeded upon the ground that such ammunition is likely to be sooner replaced by some of a superior description." Then the total number of concussion fuzes in store is only 12,129.

3913. Will you now kindly state your reason for not approving of a mechanically fitting projectile?—I identify the mechanically fitting projectile with the polygonal system of rifling.

3914. But is not the French system one of mechanically fitting?—No, certainly not; the French use soft metal studs.

3915. But they fit mechanically do they not?—No; they fit by compression; self-adjustment; we have no system of mechanical fit except in the system of polygonal rifling.

3916. Is not the Lancaster system a system of mechanical fit?—In the Lancaster system there is no attempt made to obtain coincident surfaces. You may call every gun which is destitute of a soft surface, a "mechanical fit," but by mechanical fit, I mean a projectile which is dressed to a perfect form so as to coincide with the form of the bore.

3917. You mean the coincidence of the projectile with the form of the bore?—The attempt at the coincidence of the projectile with the form of the bore.

3918. Is it not the case with oval shot as well as in the polygonal system of rifling?—I think not; because there has been no attempt made to turn it; more recently, turned shot have been used, and there you, perhaps, might call it a mechanical fit.

3919. The studs upon the French gun fit mechanically into the grooves of the gun, do they not?—No, they are of a soft material.

3920. Still they fit into the grooves, do they not?—No, not accurately. The great distinction is this, that if you use a soft material, if there be a prominence on any particular point, it will yield until the other parts come up and take their share of the pressure; but if you use an incompressible material, you get no self adjustment, and the whole pressure must be borne by those prominent parts; in the one case you attempt to form the projectile so accurately that the pressure shall be distributed over a considerable surface by mechanical fit; in the other case, you get that distributed bearing by self adjustment; but, in order to do that, you must use a soft material. Now the French do use a soft material; and, therefore, I class their system as a self-adjusting system, and not a mechanically fitting system.

3921. Then, probably, the term "mechanical fit" is a wrong term; because, undoubtedly, the projectile in the French system does fit mechanically into the gun?—According to that view, you

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you may consider every muzzle-loader a mechanically fitting gun.

3922. Then your objection reduces itself to an objection to the polygonal form of mechanical fit?—No; my objection applies also to the Lancaster system; but it applies more especially to the polygonal system of rifling.

3923. Does it apply to the French system of soft metal studs?—No.

3924. It applies to the Lancaster system and the polygonal system?—Yes, to both those systems.

3925. Will you state your objection to the polygonal system?—My great objection is that it involves a very much greater amount of friction than the system of grooves; and that the friction may, in certain cases, rise to a limit which may endanger the stability of the gun, and will probably in all cases prove detrimental to its endurance. I am quite prepared, if the Committee wish to hear my views upon that subject, to enter into it fully; but it is quite a technical subject.

3926. My question referred to your statement that mechanically fitting projectiles vibrated in issuing from the bore?—I do not think that I said so, but at the same time I think they do; and I think in the polygonal system the projectile does really vibrate, notwithstanding the tendency which it has to centre itself. The foundation of the idea that steadiness would be obtained by the polygonal system of rifling would be that the effort to give rotation to the projectile tends to direct the projectile towards the centre of the bore, but I find from most unmistakable evidence that the projectile in passing through a rifled bore does not continuously hug the driving side, but bounds from it by a succession of leaps. Well then, at the moment when it is detached from the driving side in the polygonal system of rifling the projectile would be loose. It is only at the moment when it is actually in contact with the driving side that it is steady. When it loses that pressure it is free to vibrate.

3927. What reason have you to believe that it makes a succession of leaps?—Because in my shunt gun the impression on the soft metal, shows whether at the moment of taking the impression the bearing side of the rib had been in contact with the driving side of the groove, and I find distinctly from the succession of marks and from the variation in the length of the impression that the rib is very frequently not in contact with the driving side of the groove at the moment of its leaving the gun.

3928. Is your opinion, with respect to the effect of a mechanically fitting projectile in the polygonal system of rifling, based on actual experiments or only on theory?—It is based on experiments with my own projectile and also upon theory.

3929. With your own projectile, in what gun?—The shunt gun more particularly.

3930. When was that shunt gun first used?—It has been in use for, I should think, nearly three years.

3931. Were experiments upon this question made previously to your adopting a particular system of rifling?—No.

3932. You made no experiments with respect to the effect of a mechanically fitting projectile previously to adopting the system of a soft lead coating?—No; but, in fact, I do not think there is any such thing as a mechanically fitting projectile; that is to say, I think you cannot make the projectile in such a manner as to fit mechanically in the sense which you contemplate.

3933. But, without assuming a perfect mechanical fit, did you make experiments with projectiles assuming the shape of the bore previously to your adopting your own system of rifling?—No.

3934. Mr. *Baring.*] Why did you not do so?—I think it is theoretically wrong. I am quite prepared to explain my reasons for that opinion if the Committee wish.

3935. Mr. *Vivian.*] Do you consider that a soft material diminishes friction; are you of opinion that a soft metal bearing would be a good bearing where considerable friction exists?—If you compare the friction of the soft metal in my system of rifling with the friction of the hard metal in the polygonal system of rifling, then I say the friction of the soft metal is less than the friction of the hard.

3936. Would you adopt such metal for the journal of an engine?—That is quite a different case; there the friction would be less; but as a general principle, the friction of a soft metal on a hard, would be less where the pressure is such as to cause abrasion of the surface; up to that point, the friction of a hard metal would have the advantage.

3937. But does not abrasion commence immediately when you have friction?—By abrasion, I mean an actual tearing of the surface.

3938. But does not that abrasion take place whenever you have no lubrication?—No; not necessarily so.

3939. Would not the ordinary journal of an engine abrade if it were not lubricated?—No doubt it would in time, whether lubricated or not. By abrasion, I mean an immediate tearing of the surface, not a gradual polishing effect. The reason why there is so much greater friction in the polygonal system of rifling is that the surfaces, which communicate the rotation, are inclined to the radius of the bore, instead of being coincident with it.

3940. But I am speaking now of the generally accepted opinion with respect to bearings producing or not producing friction; and I ask, whether it is not the fact, that a hard metal, such as bronze, is invariably used for bearing surfaces?—But it does not follow that it can be properly used in a rifled gun, because the pressure there is enormously greater than in machinery bearings; besides, you only get the bearings on points and edges, and cannot obtain a bearing on extended surfaces.

3941. But, surely, the friction of the machinery on a soft bearing, such as lead, would be very great?—Lead would crush; but the friction of a hard on a soft metal, even in machinery, is not uniformly greater. It is very common in machinery bearings to use a soft white metal, composed of tin and lead; but the case of machinery, and the case of gunnery are so different that you cannot reason by analogy at all.

3942. You have stated, have you not, that the bruises upon armour-plates produced by large shot were worse than holes in those plates produced by small shot?—No, I think not. I said that the projectile of a large-bore gun would, in piercing the plate, effect a greater amount of damage than the projectile of a small-bore gun. A large projectile has the disadvantage in penetrating power, but the advantage in destructive effect.

3943. But I understood you to say, that even if it

if it did not penetrate, the bruising of the plate by the large projectile was more destructive?—No.

3944. Have you seen Mr. Krupp's steel guns tried during the time you were Director of Ordnance?—Yes; I know all about those trials.

3945. But you did not recommend to the Government that they should adopt a similar system of manufacture, did you?—Certainly not. We had had no experience of Krupp's metal to justify the general adoption of it for solid guns.

3946. Will you state to the Committee why you did not recommend the adoption of that metal during the time you were Director of Ordnance?—Several of the guns that had been tried had failed. We find it almost beyond our power to obtain a block of steel sufficiently large for making even the barrel of a gun, but the difficulty would be enormously increased if we were to endeavour to obtain a block large enough for the entire gun.

3947. Did you examine the guns shown by Krupp in last year's Exhibition?—Yes.

3948. Did you find flaws in those guns?—You cannot tell what flaws exist. It is the greatest of my objections to solid guns, that you can never be sure whether there are flaws or not. You may have very perfect specimens of guns, but the whole question with respect to steel as applied to gunnery is as to getting it uniformly good. Of course, if you get a large per centage of failures the result is ruinous.

3949. Colonel *Dunne.*] You say that there would be more friction in a polygonally rifled gun than there would be in an Enfield rifled gun where the pressure was direct, because in a polygonal gun the pressure would not be at right angles to the axis of the barrel; will you explain that to the Committee?—Yes; I have diagrams here (*producing diagrams, copies of which are in the Appendix*) which will make that quite clear. In order to make myself understood, I fear I must begin in a very elementary manner. I would therefore observe that a rifled projectile in passing through the bore of the gun acquires two motions; first, a forward motion, which is derived directly from the pressure of the gas on the base of the projectile; and, secondly, a rotative motion, which is indirectly derived from the pressure of the gas, but directly from the pressure of the grooves. Now the question is, what is the amount of friction which is involved in the pressure of the grooves against the shot. The condition which would involve the least amount of friction is shown in Diagram No. 1, in which the driving surface is in the line of the radius and the propelling force perpendicular to it; but if, instead of being in the line of the radius, the driving surface be inclined to it at an angle, then a wedging force will be exerted tending to split open the gun, and that wedging force will be attended with an increase of pressure in the driving surface. Now, to apply that to the polygonal system of rifling, I will take, in the first place, a perfect hexagon, such as is shown in Diagram No. 2, not a hexagon such as is used in Mr. Whitworth's gun, in which the angles are cut away, but a hexagon in which the angles are retained. I will assume, also, that the pressure, which gives the rotation, acts at the edge of the driving face, where it will be always attended with the least amount of pressure. You will observe in the diagram, the angle which is formed between the radius and the driving surface is an angle of 60 degrees. Now the question is, what is the amount of pressure existing upon that inclined surface in producing the rotation, as compared with the pressure which would produce the same effect if it acted tangentially, as is shown in Diagram No. 1; that is arrived at by a simple parallelogram of forces. It is very easy to resolve the normal or perpendicular pressure upon the base into its component parts; that is to say, into a force acting radially to produce the outward thrust, and the force acting tangentially to produce rotation. The tangential force is represented by A, B, the actual pressure on the face is shown by A, C, and the outward thrust is shown by A, D. Now we will next take the case of a hexagon with the angles cut off, and proceed in the same manner. In that case you will see that the angle between the radius and the driving side is increased to 66 degrees. The effect of the cutting off of the angle is to shorten the breadth of the bearing surface. Now by constructing a parallelogram of forces in the same manner as before, you will perceive that the vertical or normal pressure, as compared with the tangential pressure necessary for rotation is increased to the extent indicated by the greater length of the line A, C. In the former case, if the tangential force be expressed by unity, then the pressure upon the inclined face of the projectile will be 2·05, but if you cut off the angles you will increase the pressure on the face to 2·55, that is to say, two and a half times as much. Now it is contended in the system of mechanical fit, that it is practicable to make those surfaces so accurately coincident that you can distribute the pressure over a considerable portion of the driving face, and that you gain in doing so an advantage in diminishing the friction. Now that I deny. I deny that it is possible to make the projectile so accurately correct as that it shall bear evenly on all the faces. But we will assume that it is practicable to do that over a fourth of the bearing surface. We have then to ascertain what will be the average amount of pressure operating on that portion of the surface. In order to arrive at that we must ascertain what it would be if concentrated at the inward extremity of that portion of the bearing surface, and we must draw a radius which will form an angle of 77 degrees with the driving side, and then construct a parallelogram which will show the pressure at that point increased in the proportion of A, C, in Diagram No. 4; that is to say, if the pressure were all concentrated there, you would have a pressure four and a half times greater than the minimum pressure necessary to produce rotation. Well, then, putting the two extremes together, and taking the mean between them, you would have in this case, roughly speaking, a pressure three and a half times greater than if you operated with the driving surfaces in the line of the radius. If you bring the pressure still nearer to the centre of the face you increase the pressure still more, and, mathematically speaking, before you arrived at the centre you would get a point at which the pressure would be infinite; therefore, if you took the pressure near the centre, you would infallibly have a dead jam of the shot. In order to satisfy the Committee that this is not mere theory, I will show you the effect by a model which I have prepared (*producing a model*). Here is the polygonal form of the bore; here is a block fitting that form of bore; that block, you will see, is inserted in this manner. Now if I turn the block in this direction, it bears upon the angle; but if I turn it in the other direction, the bearing operates near the centre,

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centre, because the angle is cut away on that side; and you have a great increase of the friction. Now, though I contend that it is quite impossible so to adjust the surfaces as to get a uniform bearing, yet accidental causes may arise which will bring the pressure to operate near the centre of the face; for example, the effect of the wear of the projectile is to reduce the driving face at the corners, the pressure being on the angle, or, in other words, to make it round in the centre. The moment it becomes round in the centre, it then exercises a pressure on the shot nearer the centre of the face, and you then get into a condition of excessive friction. Again, you may have a flaw start in the gun which may be near the centre of the face, or a shell may burst in the gun, which may cause an injury near the centre; and any of those accidents may cause friction, which may even produce actual jamming. Now this assumes that it is really practicable to make the projectile bear uniformly over all the faces. But I contend that that is absolutely impossible. It is perfectly certain that no contractor would supply these projectiles without being allowed a certain limit of variation; and any limit of variation, however small, would be fatal to the fit. You would then have the bearing operating upon narrow edges, or on mere points. It is perfectly well known that you cannot make an inflexible table to rest equally on more than three legs. Multiply the legs as you please, the legs will still take the bearing on three points only. And so it must be with a rigid projectile. It is impossible to get it to bear upon more than three faces, and then only upon mere lines or points. If it so happens that those lines or points are near the centre of the face, then you have this great liability to stickage of the shot; but, in all cases, the obliquity of the face to the radius will involve a great increase of pressure.

3950. I suppose there can be no doubt as to the fact that in experiments with the Whitworth rifle made at Enfield there has been shown the superior amount of accuracy which has been reported, notwithstanding that in these rifles the pressure is towards the centre of each face, as you have stated?—With respect to the small projectiles, the pressure is so insignificant that these difficulties never arise, and more than that with a soft projectile you have the advantage of a self-adjustment that will accommodate itself to the form of the bore; but even were it is a soft projectile, you have always that liability to crushing. If, however, you have a hard metal, the effect is a tearing of the bore, or a locking of the projectile.

3951. Do you not in that mode of rifling obtain greater accuracy?—Yes; but there are great disadvantages, and the question is whether you can attain the same advantages without incurring those disadvantages; I think there is nothing gained by a mechanically-fitting projectile which you cannot obtain by a projectile with a soft surface.

3952. Do you think that this immense friction would cause the destruction of a gun at a very early period?—With the larger guns, undoubtedly; but with the smaller guns it is different. I have no belief that a gun of seven inches diameter, with a shot of 150 lbs., can be made durable with that form of rifling.

3953. At Shoeburyness is there any gun which has sent shot with such force through the sides of a target as one of those very guns?—That result depends upon the hardness of the metal of which the shot is made, and the smallness of the bore, and is perfectly independent of the rifling.

3954. And of the construction?—The construction of course is a matter of strength.

3955. Captain *Jervis.*] These objections to a mechanically-fitting projectile are nothing very new in the scientific world, are they?—Certainly not.

3956. They were all laid down by Sir Howard Douglas 12 years ago, in his book on naval gunnery, were they not?—I do not recollect.

3957. Colonel *Dunne.*] Have you seen the experiments, and a machine with two plates, made by Mr. Whitworth to show perfect contact?—Yes; I have no doubt you could fit a shot by filing, and so obtain an approximate contact, but you cannot manufacture projectiles in that way; any manufacture would require a certain amount of variation, if it were only half of the hundredth of an inch, but even half of the hundredth of an inch would be destructive of accuracy. If you consider the enormous forces which are necessary to give these high rotations to heavy projectiles, it must be obvious that it would be very injurious to the gun.

3958. Mr. *Vivian.*] But is it not very desirable to test by actual experiment whether your theory is correct or otherwise?—Actual proof exists in the model which I have produced.

3959. I mean actual proof by causing to be cast a certain number of shot by open sand casting, or in any other rough manner, in order to see whether such misfortunes would actually occur?—No doubt you might make experiments which would test it.

3960. Do you not think it very desirable to make those experiments?—Perhaps it would.

3961. Captain *Jervis.*] Those experiments have already been made to a certain extent, have they not?—Experiments have been made with brass guns.

3962. And also with wrought-iron guns?—With the cast-iron guns in the service.

3963. Colonel *Dunne.*] Have you seen those brass guns that were tried and returned lately as injured?—No; but I have all the particulars of the injuries done to them.

3964. Do you think that those injuries bear out your theory?—I do indeed; quite so.

3965. Mr. *Vivian.*] Were not those brass guns fired a very great number of rounds without lubrication?—Yes; but they were enlarged in the powder-chamber behind the shot, where they were quite independent of lubrication.

3966. But were they not first proved with very heavy charges?—Yes; but they were enlarged under practice. In the powder-chamber the bore is increased in diameter, so that it is plain the guns were in process of destruction.

3967. Was not that owing to the heavy proof charges?—No, I do not understand so. I am satisfied that no brass gun of 14 cwt. would bear such a charge with such a projectile as is used; that is my firm opinion.

Jovis, 11° *die Junii*, 1863.

MEMBERS PRESENT:

Mr. Baring.
Mr. Beecroft.
Mr. Dodson.
Colonel Dunne.
Marquis of Hartington.
Sir John Hay.
Captain Jervis.
Mr. Laird.
Mr. Monsell.
Sir Morton Peto.
Major O'Reilly.
General Peel.
Mr. Vivian.

THE RIGHT HONOURABLE WILLIAM MONSELL, IN THE CHAIR.

WESTLEY RICHARDS, Esq.; called in, and Examined.

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3968. *Chairman.*] YOU have paid a good deal of attention to rifled guns, and also to rifled ordnance, I believe?—To rifled small-arms; I have not had much experience in rifled ordnance. I am now engaged in perfecting a plan for loading at the breech, which I have proposed.

3969. But you were very much engaged in the introduction of the Minie rifle for the service, and at that time you had of course great opportunities and have continued to have them since, of studying the theory at all events which may be applied to rifled ordnance as well as to small arms?—Yes, I have.

3970. I see you have publicly stated with respect to the Committee which decided on the introduction of the Armstrong gun into the service, that the chief and most reasonable ground of complaint would appear to you to consist in the Committee not having made a sufficient number of comparative experiments before coming to its decision, at least that there is no record of such experiments published in the Report of the Select Committee on Ordnance; will you kindly explain exactly what you mean by that?—In reading the blue book of last year I find the conclusions of the Committee appear to have been arrived at from trials made with guns which differ in all their proportions, bore, length, weight, charge of powder, height and length of projectile, &c. It was impossible to have a proper comparison made between two systems of rifling with guns differing so widely in every essential particular. If I had had such a comparison to make, I should not have attempted it with the guns which were used by the Committee.

3971. I understand you to say that you consider that it was the duty of the Committee not to try one gun against another as if for a prize, but to endeavour to find out which system was the best?—I consider they should be tried one against the other, and there was only one way in which that could be done, which was to have guns made identical in every respect, except the part intended for comparison.

3972. Sir *John Hay.*] In weight?—In everything, except the rifling.

3973. Captain *Jervis.*] Supposing there were two competitors, ought they, in your opinion, to have guns of different weights?—It would not be possible to try two guns of different weights; because other conditions might enter into the case, which might have an influence on the results obtained.

3974. We have it in evidence that Mr. Whitworth considers a gun, of a certain bore, ought to have a certain weight; Sir William Armstrong thinks that weight should be less; and the Admiralty think the weight should have reference to the ship?—Those would be questions for consideration after deciding upon the rifling. I do not see how, with different descriptions of guns, the question of rifling can be satisfactorily settled, and this was the question to be tried. If, for instance, Sir Wm. Armstrong's gun was longer, heavier, and better proportioned for throwing projectiles than Mr. Whitworth's gun, it would inevitably beat it, if the two systems of rifling were of equal merit.

3975. I do not differ from you on the principle; but do you think it was the business of the Committee to insist that the guns should have a certain weight, and length of bore, and so on?—I think they ought to lay down a rule, that whatever guns are to be compared, they should be identical in all respects, except the part to be compared.

3976. Do you think they would get anybody to bring guns forward, if they laid down that rule?—I do not think it is possible to try two guns without it. I think no reasonable person could object to such a stipulation being made.

3977. *Chairman.*] In order to test the merits of systems of rifling, it is your opinion that it was the duty of the Government to direct the Committee to have guns made identical in all respects, except the rifling: and if no such guns were in existence, no fair comparative trial could possibly take place, in your opinion?—Yes; that is my opinion.

3978. Captain *Jervis.*] We have had evidence before us that Mr. Whitworth, wishing to throw a bolt through an iron ship at 800 yards, considered it necessary that his gun should have a certain thickness,

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thickness, in order to stand a large charge of powder. Now could any Committee regulate that?—They might have requested Mr. Whitworth to comply with certain conditions, saying, they had got Sir William Armstrong's gun, of a certain length and size, and they must have his gun made like it.

3979. But suppose he said that it was not his principle?—The proportions of a gun are not part of a principle. The rifling was the principle which was to be tried.

3980. Suppose he said, My principle is to fire with a very large charge of powder, and I must have a gun of a certain thickness?—If I were going to make the trials, and could not get Mr. Whitworth to make his gun the same as the Armstrong, I should have the Armstrong gun made like the Whitworth. I do not consider a large charge of powder to be a principle. I should not under any circumstances give up the proper mode of comparison.

3981. Supposing the Admiralty, on the other hand, said, "We cannot have a seven ton or a ten ton gun?"—Then, I think, the proper thing would have been for the Government to have a gun made on the Whitworth principle, identical with the 18-pounder or 12-pounder of Sir William Armstrong's, or of any other suitable bore which would come within the weight required by the Admiralty.

3982. Then you put the Government in this fix, that they are to decide as to whether they are to take the heaviest or lightest gun, and insist on having everything else to match?—If two systems are being tried, it is quite impossible to try them in the way I see they have been tried here. One gun is firing a charge of eight to one of powder, and is 32 calibres in length; while the Whitworth gun is firing a charge of four and a half to one of powder, and is only 20 calibres in length. It is impossible to settle a system of rifling when the two guns differ so completely.

3983. I agree with you personally; but I want to know whether you think it is the duty of the Government to give such instructions to the Committee?—I think it the duty of the Government to give instructions to the Committee, that when a principle of any kind is being tried, such as a system of rifling, that the guns used in those trials should in all cases be identical as well as the charges.

3984. Sir *John Hay*.] I think it would be very desirable if you would add to the evidence, which you are now giving, the distinct limitations which you would think it advantageous that the Government should impose upon Committees when they are deciding upon the best description of rifling?—I think they should insist upon the guns being made the same length, the same weight, the same diameter outside the barrel, and the same diameter of bore before rifling, and also that the guns should be constructed in the same manner, and of the same material, fired with the same charges and quality of powder, and the same length of projectile.

3985. This Committee would like to know the mode in which you think it right the list should be ranged, so that the question of rifling should be fairly settled between the different guns; is there anything you would like to say upon that subject?—A table of this description might be drawn out for purposes of comparison. (*Witness handed in the same.* Vide *Table* (C), *Appendix.*) The table is filled up with 116 cwt. guns, of what I consider to be true proportions. The guns being identical in all respects, except in the rifling, the principle of which it is proposed to try. It is not necessary in the first instance to make the trials with guns of so large a size; smaller guns would answer the purpose if the proportions were the same. But before the whole question can finally be settled, it will be necessary.

3986. What do you think is the proportion which the gun should bear in weight to the projectile?—If nothing else is taken into consideration, except the best means of throwing the projectile, I think the proportions should be 145 to 1.

3987. How many diameters?—The projectile should be $2\frac{3}{4}$ diameters in length.

3988. And what weight of powder?—Six to one, I find, is the best. All these particulars will be found in the table I have put in.

3989. What length of bore?—That is a question I have no experience about in large guns. We find in small guns that we get an advantage up to 70 or 80 times the diameter of the calibre; that, of course, is out of the question in large guns. I should think somewhere about 26 to 30 times would be sufficient; that is, for a perfect gun irrespective of all special services, and where the weight is not considered, and the length of no importance.

3990. Then you think that by means of guns having those specified weights, and diameters, and ratios to the projectile and the charge, you would have an opportunity of clearly ascertaining which mode of rifling was most desirable?—I think so, as the greatest amount of strain likely to be required would, by this means, be put upon the inside of the gun. (*A list containing the principal questions to be determined by comparative experiments was handed in, marked* (A). *See Appendix.*)

3991. *Chairman.*] Do you consider that the present system, upon which competitive trials and experiments generally are carried on by the Government, is a satisfactory one?—I think it would be more satisfactory if the Government were to say what were the particular qualifications in a gun they required, and to attach a figure value to the same (Vide *Statement* (B), *Appendix*), it would be a great assistance to competitors; competitive trials between guns after they are perfected should also be made in public; that is to say, anyone taking an interest in the matter should be allowed to witness experiments before a final decision is come to about any particular gun.

3992. You have publicly stated in illustration of the importance of that view that a gunmaker having a proper knowledge of his business would see at once that a gun constructed on the principle of Sir William Armstrong at the breech, would not answer for large ordnance; I suppose you consider generally that the scientific knowledge and intellect of the country is not sufficiently brought to bear upon these questions?—I think anyone having experience in guns would not have breeched a gun in that manner, he would have seen at once it would not answer for large ordnance; I consider a gun, to fire a conical projectile, should have at least three or four diameters of the bore in solid metal at the breech end; the Armstrong gun has not one.

3993. Will you favour the Committee with your view with respect to the manner in which you think scientific men should be allowed to take part in those experiments?—I think when scientific

scientific men ask permission to witness experiments, they ought to be allowed to do so.

3994. Has that not always been the case?—No; I was refused; I asked permission to see some experiments at Shoeburyness. I was anxious to see some large guns tried; there was a trial of Sir William Armstrong's and Mr. Whitworth's large guns, and also of Mr. Lynal Thomas's gun, and I was refused permission to see these guns fired.

3995. Captain *Jervis.*] When was that?—At the last trial of Mr. Lynal Thomas's large gun.

3996. Then how do you account for the account of all those trials, however important and private they may be, always appearing in the press, the next day, perhaps, with details which only witnesses could have knowledge of?—Newspaper reporters have permission, I suppose, to attend; I was told at the War Office that none but military and naval men could be allowed to be present.

3997. Mr. *Laird.*] All you know is that you have been refused admission to those experiments?—That is all I know.

3998. Mr. *Dodson.*] Have you heard that, as a rule, no inventor is allowed to be present at the trial of any other inventor's gun?—No; I have not heard that.

3999. Are you aware whether Mr. Whitworth has ever been permitted to be present at a trial of Sir William Armstrong's gun?—Do you mean when his own guns have been tried?

4000. At a trial of Sir William Armstrong's gun; or do you know whether Sir William Armstrong has ever been allowed to be present at a trial of Mr. Whitworth's gun?—I do not know whether Sir William Armstrong has been admitted to the trials which were made strictly with Mr. Whitworth's gun, or *vice versâ*.

4001. The reason assigned for not allowing you to be present, was that you were neither a naval nor a military man?—Those were the reasons assigned.

4002. Are you aware whether that was a trial before any special committee appointed by the war office?—The last time it happened to me, was when Mr. Lynal Thomas's gun was being fired.

4003. To whom did you apply?—To the War Office. I wrote to Mr. Lyon, he informed me none but naval and military men were permitted to witness the experiments.

4004. What was the gun that was to be tried on the former occasion?—One of Mr. Whitworth's and some of Sir William Armstrong's.

4005. Did you then apply to the War Office?—Yes, I applied to the War Office, and was refused; I afterwards went down, Mr. Whitworth gave me a ticket.

4006. Then you were present at the experiments?—At the experiments I allude to.

4007. What guns were experimented upon. upon that occasion?—Mr. Whitworth's large gun.

4008. And no other gun?—Some of Sir William Armstrong's was experimented upon.

4009. Was Sir William Armstrong present?—Yes.

4010. Was Mr. Whitworth present?—Yes, both of them, and both their guns were being fired.

4011. Each was present at the firing of the other's gun upon that occasion?—Yes.

4012. Sir *John Hay.*] I believe that that was a trial of plates only, the guns having already been tried before they were guns placed in a battery for the purpose of testing certain targets, were they not?—Yes.

4013. It was only collaterally that there was any evidence with regard to the quality of the gun?—No.

4014. Mr. *Dodson.*] Those experiments were rather for the purpose of testing the strength of certain iron plates than for the purpose of testing the guns?—Yes.

4015. Mr. *Beecroft.*] You know the Royal Gun Factory at Woolwich?—Yes.

4016. In your opinion, should the superintendence of the Royal Gun Factory be under a military officer or a civil engineer?—I should think that the superintendence of the Royal Gun Factory should be under a civil engineer.

4017. *Chairman.*] Would you state your reason for that opinion that the head of the department should be a civil engineer, and responsible to the Government?—I think that a person who has the management of so much machinery, and who is responsible to the Government, should be a civil engineer, as his education would be more likely to qualify him for the duties he has to perform than any other person.

4018. Captain *Jervis.*] Do you think that a military man could not have the same knowledge as a civil engineer?—I think a man who is bred up to be a civil engineer must understand more about the invention and application of new machinery than a military man who only devotes a small portion of his attention to the subject.

4019. Take Colonel Symons, of the Engineers, he was one of the very first men who practically brought out the question of wrought iron guns; are you aware of that?—I did not know that.

4020. *Chairman.*] Are you speaking more theoretically than from what you have observed on the subject?—I have not paid any special attention to the subject, but I am of opinion a man who had been brought up as an engineer would be more capable of conducting all the details of a manufacturing department than a military man.

4021. Then you would, I suppose, apply that observation to all the manufacturing departments. You could hardly draw a distinction between the Royal Gun Factory and the Royal Laboratory, for instance, could you?—Yes; I think there is a great deal of difference between the two.

4022. Will you explain to the Committee why you think that a military man should be at the head of the Royal Laboratory and not at the head of the Royal Gun Factory?—I think there is a great deal in the Royal Gun Factory connected with machinery and lathes and new modes of doing work, which are matters more fitted for an engineer than a military man.

4023. You do not consider, then, that all those matters are within the scope of the military man who may be at the head of the Royal Laboratory?—I believe the machines in the Royal Laboratory have been most of them designed from the Royal Gun Factory, and from what I understand, made at the Royal Gun Factory, but I have not made it my business to enquire into these details.

4024. Captain *Jervis.*] Do you remember the late Colonel Colquhon, of the Artillery?—Yes.

4025. And do you remember Mr. Nasmyth and others who gave evidence before a Committee that the Carriage Department under him was a model establishment to all kinds of establishments in the country, because his knowledge of mechanics and machinery was so great?—That is possible.

4026. Mr. *Vivian.*] I wish to ask whether you think

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think that sufficient experiments had been made heretofore previously to the adoption of the Armstrong guns into the service?—I do not think that sufficient experiments were made before the Armstrong guns were adopted into the service, particularly the large guns.

4027. Do you think that a sufficient opportunity has been given to all inventors since that period to have their guns properly tried?—I do not think that the Committee have thrown any very great difficulties in the way of inventors; I can speak only for myself. I have had no difficulties thrown in my way at present, and have been allowed to make new guns, but I have not yet got to comparing them with Sir William Armstrong's guns; as I have said before, I do not think the Committee assist inventors as if they desired their inventions to succeed.

4028. When did you commence manufacturing large guns?—I think about a year ago, and I have now got a 12-pounder on my own principle, and a larger gun, a 150-pounder, in process of manufacture.

4029. Have you any reason to believe that, previously to a year ago, such difficulties existed as made it almost impossible for inventors to obtain a proper hearing in official quarters?—I have heard complaints made by inventors about the difficulty thrown in their way. I have no experience myself of being prevented from obtaining a hearing.

4030. You have already stated that you adhere to the plan suggested in your pamphlet for conducting experiments previously to the adoption of any particular system?—Yes; I adhere to every word in my pamphlet, and I believe the plan of proceeding there proposed to be the only way of arriving at the best gun.

4031. You gave an opinion that a civil engineer would be better qualified than a military man to conduct such an establishment as the Royal Gun Factory. I presume that you mean an engineer who has been brought up from his youth in the management of tools, and in manufacturing steam engines, and other engines, and so on?—Yes. I mean a regularly educated civil engineer.

4032. So far as you know, is the education of an artillery officer, a fitting education for that description of work?—I should think not; but I do not know enough about it to say. I think the management of a large engineering department is a business of itself.

4033. In fact, a military man would have to learn his business at the same time that he was conducting the establishment?—Yes, he would have to learn his business.

4034. Captain *Jervis.*] Then, how do you account for the fact that a company like the Elswick Ordnance Company, went to the Artillery to get a man like Captain Noble, to assist in carrying on their business?—Such a gentleman may be useful in some branches of the business; but I think a man, educated as an artillery officer, does not know enough about lathes and machinery and the general details necessary to conduct a business, to be at the head of a large establishment like the Royal Gun Factories.

4035. Are you aware that that is part of his education?—Not making special machines for special purposes.

4036. Are you aware that that is part of his education, to a very great extent, and that he would have to spend several years in instructing himself in those matters?—I do not believe, unless he serves a regular apprenticeship to such matters, he can be so well fitted for them as a civil engineer, who has been brought up to the business.

4037. But still the mere fact of his being an officer of artillery, does not prevent his fitness; his previous education would be rather an assistance to him than otherwise, would it not?—Yes, certainly, but he would still have to learn his business.

4038. Major *O'Reilly.*] Whilst a part of the education of an artillery officer is, as the Honourable Member has just stated, directed to the knowledge of making machinery, the whole of a civil engineer's education is directed to that class of subjects?—Yes, that is the case.

4039. Captain *Jervis.*] Take the Polytechnic School at Paris; are you aware that all the civil engineers and officers of artillery both come out of that school?—Yes.

4040. The French engineers are not such a very bad sample, are they?—I do not think they are equal to our own; I allude to the private engineering establishments.

4041. Mr. *Laird.*] You are aware that in the Polytechnic School at Paris it is selected for a young man which branch he has to go to, mechanical, engineering, artillery, or any other branch?—Yes.

4042. So that after he leaves the Polytechnic School, he has to perfect himself in that branch?—I believe so.

4043. Captain *Jervis.*] It is the same thing in the artillery, is it not?—Yes; but still the military man cannot have the same knowledge as a man who has devoted the whole of his life to the subject, and he must begin in a subordinate position.

4044. *Chairman.*] Do you think that matters are managed better or worse under artillery officers at Woolwich than in private establishments, which are well managed?—I think some private establishments are managed better, though of late years everything at Woolwich has made great advances.

4045. Will you mention any private establishment which is better managed than the Royal Laboratory or the Carriage Department at Woolwich?—I believe the two departments mentioned are managed as well as anything can be.

4046. They are under artillery officers, are they not?—I believe nothing can be better; but we have no means of knowing they are managed to a profit, and this is the part where good management is shown.

4047. Take the case of the Royal Gun Factory, in which the guns were, many of them, turned out in a very imperfect state; were they, during that period, under an artillery officer or a civil engineer?—That was most probably owing to a new system of manufacture, which was a very difficult one, and would take some time to perfect; any one would be liable to failure at first on a production of that kind.

4048. Was there not a system in the ammunition manufacture in the Royal Laboratory for the Armstrong gun?—Yes; but the manufacture of ammunition and the manufacture of rifled cannon are two different things.

4049. But are you not aware Sir William Armstrong has stated before this Committee that he found very much greater difficulty with the ammunition than with the gun?—No, I am not aware of that.

4050. Mr. *Laird.*] I think he said that with reference,

reference, not to the question of manufacture, but of invention?—Of invention, I think that possible, but the manufacture ought to be simple when once the patterns are decided upon.

4051. You allude, when you speak of an engineer, to a mechanical engineer properly brought up to that branch of civil engineers?—I meant a mechanical engineer.

4052. Of course, an artillery officer, if he has to learn all the branches of his own business, and, in addition, to learn the business of a mechanical engineer, cannot be so perfectly acquainted as a man who has made it the study of his life?—I think not.

4053. Do you think it an advantage to an inventor to be present on all occasions when the guns of other persons are to be tried?—I do not think it would be right, till an invention is perfected, to have other inventors present.

4054. But afterwards, do you think it would be an advantage to allow inventors to be present at the trials of guns made by other inventors?—I do not think that is necessary, unless the guns were being tried one against the other.

4055. Would that be an advantage to an inventor?—I think it would certainly be an advantage, as he could not fail to gain information by seeing new inventions tried.

4056. Then, I will read you the definition of Sir William Armstrong's duties: "He shall conduct all experiments and investigations which may be sanctioned by the War Department, for the purpose of developing his system or for the improvement of rifled ordnance generally." According to that, Sir William Armstrong was to superintend all experiments and investigations for the improvement of ordnance generally; would that be an advantage to Sir William Armstrong as compared with other persons who were refused admission?—A decided advantage.

4057. Have you heard the amount which has been spent on Armstrong guns and projectiles?—No.

4058. It is stated that two millions and a half to three millions have been so spent; do you think it would have been advantageous, if a portion of that money had been expended for the purpose of bringing forward other inventions?—Yes; I think if there had been a proper competition with the Armstrong gun it would have been a great advantage to the Government, and a better gun would have been found.

4059. In your opinion, did Sir William Armstrong's position, as engineer for rifled ordnance, give him an advantage over you and other parties who were not allowed to be present at the experiments?—Yes, certainly; witnessing experiments with new guns is always an advantage.

4060. Captain *Jervis.*] Can you mention any one instance that you know of in which Sir William Armstrong was constituted a judge in the case of any system of rifling?—I do not know that he was; he was a member of the Committee that recommended his own 110-pounder gun to be adopted in the service.

4061. In paragraph 6 of the document which contains his instructions it is distinctly stated that if a Committee should be appointed Sir William Armstrong should only serve under directions from that Committee if he was wanted. Are you not aware that in a case where any inventor brought forward an invention it was submitted to the Committee quite independently of Sir William Armstrong?—I know that all inventions are now submitted to the Ordnance Select Committee, but I understood that Sir William Armstrong had an opportunity of seeing all new inventions tried, which must have been an advantage to him.

4062. You mean as engineer of rifled ordnance?—Yes, as engineer of rifled ordnance.

4063. Do you think it would be advisable for any country, instead of having a connected system of artillery in its service, to go on with experiments from year to year, never coming to a decision?—Certainly not.

4064. But in this age experiments and improvements are going on daily, are they not. You have yourself perfected a small bore breech-loading gun, which some years ago you would little have dreamt of; do you therefore think it would have been advisable for the Government to refrain from adopting a system of rifling for arming their troops until you had come to that point at which you have now arrived?—No; certainly not.

4065. Do you think it would have been wise, when a system of rifled artillery was required, that the Government, instead of adopting Sir William Armstrong's system, should have given no orders at all for rifled guns until we obtained a perfect system?—No; that would be out of the question.

4066. Do you not think that we may almost say that perfection in rifled ordnance is a thing we may all hope for, but which neither of us will live to see?—Yes; it will take a great many years to perfect; but I believe it can be done by a properly organised system of experiments.

4067. We must make use then of the best system for the day?—No doubt.

4068. That must necessarily entail a greater expense than if we could foresee what would take place years hence, and act accordingly?—Yes.

4069. Do you not think it is rather an awkward thing to assume to be able in 1863 to state that if we had known all that we do now know in 1856, we might have saved a considerable sum of money?—Yes; but what I say is that it does not appear, from the records published, a sufficient number of trials were made in the comparison of other guns with the Armstrong guns, or made in a proper manner; nor was the competition thrown sufficiently open.

4070. Will you state what trials ought in your opinion to have been made previous to the adoption of that gun?—There was another gun in existence; and I have already stated how, I think trials ought to be made.

4071. Which gun was that?—The Whitworth gun.

4072. A system of rifling?—Yes.

4073. Was that not fairly tried at the time?—This is going back to the question of trials; there were no guns in existence at the time with which the two systems could be fairly tried.

4074. Therefore, the Government did what they thought right in taking the best gun which was then in existence?—Yes; they took the gun that was recommended by the Committee. They had no other course to pursue.

4075. Are you aware of any gun that is now in existence which is better than the Armstrong gun?—I know of none; but I have not seen Mr. Whitworth's gun properly tried.

4076. Still you are, yourself, a very good judge in the matter, and you constantly mix with men who are engaged on the subject. Do you know of any gun which you consider the Government ought to adopt, instead of the present artillery gun?—

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gun?—No; I have had no experience in large ordnance. I have not seen Mr. Whitworth's or Sir William Armstrong's guns much fired, and therefore cannot give an opinion of their respective merits, and I know less of any other gun.

4077–8. Still, if there had been such a gun in existence, you would most probably have heard of it?—I think I should have known of it.

4079. Colonel *Dunne.*] You say that you would recommend the admission to the trials of all persons who wish to see inventions. Do you mean to extend that permission to every person who wishes to go?—No; they should show some sufficient reason for making the request; all scientific men, who are interested in questions of gunnery, or military men should, in my opinion, be admitted. By that, I do not mean admitted to see all preliminary trials, but trials after a gun is perfected, and competitive trials between two or more guns; all new guns would be better subjected to public criticism before it is determined to adopt them for the service.

4080. A great many people would go from curiosity, would they not?—Yes, that is possible; but they should be required to show some sufficient reason for going. There is no reason for preventing those who take an interest in questions relating to gunnery from attending trials.

4081. Major *O'Reilly.*] With regard to the expenditure on Armstrong guns, an honourable and gallant Member has just put you this question: do you consider it would be advisable to have no connected system of rifled guns, and give no orders for them until we had a perfect system. But would you not consider that there might be a medium between the course indicated by the honourable Member and the expenditure of 2,500,000*l.* sterling on Armstrong guns?—I think that the Armstrong gun might have been made much more perfect than it is now, before such a large expenditure was incurred.

4082. In other words, there would have been a medium course between giving no orders and spending 2,500,000*l.* of money?—Yes; I think the defects which are now complained of might have been remedied before so many guns had been made.

4083. Mr. *Baring.*] What is your opinion of the comparative advantages of a breech-loading and muzzle-loading gun?—I think if you can get a perfect breech-loader, it must have great advantages over a muzzle-loader in many respects.

4084. Do you think that the difficulties for the large guns, as breech-loaders, will be surmounted in time?—I think so.

4085. Mr. *Beecroft.*] Do you approve of the system of accounts so kept at Woolwich?—At present, I really do not know what the system of accounts at Woolwich is. I approve of the system recommended to this Committee last Session by the War Office.

4086. You approve of that form of keeping the accounts?—Yes; but I think it would be a great advantage if the capital required for each Department could be borrowed direct from the Treasury, each Department paying the Treasury interest for the capital required.

4087. Keeping each account separate?—Yes; keeping the accounts and capital of each Department separate.

4088. Mr. *Vivian.*] Following out the question of one of the Honourable Members, I want to know whether the French Government did not, in fact, adopt a medium course at the time when rifled guns were first invented; did they not rifle the then existing brass guns, perhaps not so perfectly as that might now be done, but in such a manner as to form an efficient arm?—I believe they did.

4089. Do you not consider that the guns which were possessed at the time by this country might have been rifled, so as, at all events, to place us on an equality with France, while due and careful experiments were being made, before such immense sums were expended, and the country was tied down to one particular description of new ordnance?—I think it would have been quite possible; but no one would have been satisfied with the rifled cast-iron gun.

4090. There was the brass gun for field purposes?—For field purposes it might answer, but no one would be satisfied with a rifled cast-iron gun; and any gun must have had the bore diminished to have suited the elongated form of the shot.

4091. But I mean with a brass gun such as the French gun?—I have no doubt a very useful gun might have been made by diminishing the bore.

4092. This country might have been placed on an equality with any other country by the use of the materials then belonging to the country without going to the expense of a new system before it was well ascertained what it was?—I do not know whether brass guns are capable of being rifled, and whether elongated shot can be used, as I have not examined them with that view; unless the bore was diminished, the shot used must have been short and the charge of powder small.

4093. But that is what the French have done?—I believe they have; and I have no doubt our guns would have been as good as the French.

4094. Mr. *Baring.*] The French have been rifling cast-iron guns, also, have they not?—Yes.

4095. The main importance of their position was in consequence of the French having rifled cast-iron broadside-guns for the armament of ships, those guns being hooped, and the question was, whether we could with safety adopt the same course, and arm our ships with similar guns?—I think so. I do not think hooping cast-iron-guns is of any value beyond adding to their weight; it will not add much to their strength, in my opinion; but the Government have information on this point, which the Committee can easily obtain.

4096. Mr. *Beecroft.*] The French guns are made of charcoal iron?—Yes.

4097. And that iron is much superior to ours?—Yes; I am informed it is better than our iron; but the question of cast-iron for guns is one I have paid no attention to. I do not approve of cast-iron in any form for guns.

4098. Mr. *Vivian.*] To a certain extent, the French guns are not hooped, are they?—I know little about the French guns, and cannot say.

4099. I saw a large number at Toulon which were not hooped.—I do not know the guns. This is a question I have not had occasion to inquire into.

4100. Captain *Jervis.*] You do not know how long it is since they have got a better cast-iron gun than ours?—I do not; but I believe their guns are made of charcoal iron and ours are not.

4101. We have always understood that the French cast-iron gun would not stand one-third of the number of rounds that our guns do?—I do not know. I have never gone into the question.

4102. Colonel *Dunne.*] Considering the situation that you know our artillery are now in, and the fact of the acquisition of those Armstrong guns, what course would you recommend with regard to any change. Are you of opinion that we

we should embark in a new series of experiments with a new gun, or be satisfied with what we have for the present, continuing experiments on a small scale?—I think a proper series of experiments ought to be carried out; there is nothing to show how that Armstrong gun came into existence; it has not had any competitors with which its qualifications have been tested.

4103. General *Peel.*] Have you read the Report of the Ordnance Select Committee, which was appointed in order to inquire into the merits of the gun?—Yes, I have; but there is no gun exactly like the Armstrong gun that has been compared with it; the Whitworth gun, fired at the same time, was not in any way like it.

4104. At that time, you think, there was no other gun of that description?—No; not of the same proportions as the Armstrong guns.

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4105. *Chairman.*] You think that the Government ought to have ordered two guns to be made identically alike, except as to the rifling, to be tried one against the other?—Yes; that is the course I should have pursued.

4106. Mr. *Vivian.*] Something like 90 rounds were fired with the Whitworth gun on that occasion; should you consider that trial of 90 rounds sufficient to condemn a gun?—Certainly not.

4107. *Chairman.*] Have you anything further which you wish to state to the Committee?—No.

Captain Robert A. E. Scott, R.N., called in; and Examined.

Capt. R. A. E. Scott, R.N.

4108. *Chairman.*] I believe you have been employed by the Government to report on the defences in the ports of the Baltic?—Yes, I was sent up the Baltic by the Government on a special mission before the squadron went there in 1854.

4109. I believe that you have been present at many of the experiments with field and other guns at Shoeburyness, Woolwich, and Portsmouth?—I have been present at a great many experiments; I saw the early experiments with Lancaster guns.

4110. What other experiments have you seen tried?—I have seen several with the Armstrong guns, the Whitworth guns, and Mr. Lynal Thomas's, and other guns.

4111. What was the date of those experiments?—The date of the Lancaster experiments was 1854 and 1855, and the others were from 1859 up to the present time.

4112. General *Peel.*] 1859 was, subsequently to the introduction of the Armstrong gun into the service, was it not?—Yes.

4113. *Chairman.*] Have you yourself invented any gun; have you produced any gun before the Ordnance Select Committee?—I proposed a plan of rifling, which I offered to Sir William Armstrong, being introduced to him for that purpose by the present Superintendent of the Royal Gun Factory, Mr. Anderson, who had a good opinion of the method proposed of centering an iron shot.

4114. I will read you the Order of Reference to this Committee, "That a Select Committee be appointed to inquire into the expenditure incurred since the beginning of 1858, on the various kinds of improved ordnance, whether obtained by contract, or manufactured in the Public Departments, and into the results obtained by such expenditure." I presume the matter that you wish to give some information upon, is your opinion with respect to the results obtained by the large expenditure which has been made upon the Armstrong guns?—I am ready to answer any question that the Committee may wish; and can give information on most of the points you have mentioned.

4115. Will you, if you please, state whether you consider that the large sum of money which has been expended on Armstrong guns has been previously expended?—Certainly not.

4116. Will you give your reasons for arriving at that opinion?—In dealing with the question, I would propose to treat it as a naval question being myself a naval gunnery officer. I think it very possible that the expenditure upon field pieces being limited, might have been judicious, but with respect to the heavy guns it was very early shown that such an expenditure was injudicious. Taking the finest groved-service Armstrong guns, and supposing that all the disadvantages arising from their costliness and the extreme delicacy of the parts of these weapons, and the delicacy of their projectiles, and the tendency of the guns to shake to pieces, did not exist; there are the following strong objections to them as rifled guns: First, the want of sufficient velocity of projectile; secondly, the detention of the projectile in the bore arising from double priming and nip at starting; and thirdly, their inability to fire a round ball or molten iron, and fourthly, the impossibility of these guns re-firing their own projectiles in "practice," or using any other than their own special shot.

4117. Are you able to show that there was any better gun submitted to the Committee that introduced the Armstrong gun, or that any better gun has, during the process of this large expenditure, been brought before the Government?—I see no way in which there has been any opportunity given of testing whether there was a better gun or not.

4118. Do you object, then, to the system that has been pursued with respect to inventors by the Ordnance Select Committee?—Certainly.

4119. Will you state your reasons for that?—The guns have not been tried under the same conditions, nor were the projectiles alike in windage and weight.

4120. Does that observation apply to the experiments that were tried between Sir William Armstrong's and Mr. Whitworth's guns before the Committee of which Colonel Mitchell was president, which recommended the introduction of the Armstrong guns into the service?—From what I understand of that trial I should say it certainly did apply.

4121. Then what, in your opinion, would have been the duty of the Government in order to enable them to come to a just conclusion between those two guns and any other guns that were submitted to them?—I think they should have laid down certain conditions as essential.

4122. Will you mention those conditions?—I take it as a naval gun. An early experiment in the autumn of 1860 showed that the Armstrong 100-pounder (now called an 80-pounder) at 600 yards indented an iron plate one inch; the 68-pounder smooth bore gun firing a round ball on the same occasion, and at the same distance, indented an iron plate at from an inch and an eighth to an inch

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inch and a half. Now in the smooth bore we had a gun which showed on that occasion greater power than that of the rifled gun against an armour plate. It was therefore most desirable to secure round ball firing as an essential quality for any rifled gun.

4123. What, then, is the conclusion that you draw; is it that after those experiments so many Armstrong guns ought not to have been made?—I conclude that the Armstrong gun at that early experiment showed its inferiority to the 68-pounder.

4124. Do you consider that now, with the improvements made in it, it is still inferior to the 68-pounder?—Very inferior.

4125. Mr. *Beecroft.*] Is it inferior for long range?—At long range a different condition occurs. I now speak of naval warfare, in which, if you cannot produce an effect near, you cannot produce it at long ranges, so they are excluded. I am not speaking of another mode of rifling, by which you could throw elongated shell and round ball, from the same gun, but I speak of the Armstrong rifled piece, as compared with the smooth bore weapon, to show that even at that time there was no "necessity" to make those rifled guns.

4126. Do you confine yourself to a range of 600 yards with both guns?—Certainly not.

4127. Then what would be the comparative effect, would you say, upon 1,200 yards?—Neither would produce any injury.

4128. *Chairman.*] Do you mean against an iron plate?—Against plated ships.

4129. Do you consider it is not desirable to adopt the Armstrong guns for chase guns on board men-of-war?—Certainly it is not desirable.

4130. Will you state your reasons for that opinion?—The breech-loading arrangement is now changed into a side wedge, or is in process of changing into a side wedge, and those wedges being pulled out on each side of the breech, are very liable to be hit by the enemy's shot.

4131. Would they, during a chase, be very liable to be hit by an enemy's shot?—In chase-firing the gun has to be elevated; but in loading with a gun that loads at the breech, you must bring it horizontal before you can put in the charge.

4132. But the enemy is not very near during a chase generally?—Unless the gun be laid very exact, your shot are entirely thrown away, and you therefore want to keep it at the same elevation. Then in chase (that is to say, if you mean to do anything) you want greater exactness of fire than you do when alongside an enemy, and hence the detention of the projectile in the bore becomes a serious evil. Sir Howard Douglass, in his work on naval gunnery, has shown that from the time of pulling the trigger till the shot leaves the bore of the gun, about a second elapses, say, in the 68-pounder smooth bore.

4133. In the Armstrong gun how much will it be?—It would be considerably more in the Armstrong gun.

4134. Can you state the time?—It would require a very nice experiment to determine that, but I can say that the time is considerably greater.

4135. Is it once, or half, or twice as long?—I think it is irregular. On watching the gun it has always struck me that it is irregular, that the shot at times leaves the gun more quickly than it does at other times. Now a ship in one second will roll from three to four degrees, and if you have another half second added to that, we will say she has rolled up two degrees, in that half-second—now, two degrees at once gives you a range of 1,000 yards, so the shot pass your object altogether.

4136. Is that objection applicable to all rifled ordnance, or merely to this particular form of rifled ordnance of Sir William Armstrong?—It applies in a slight degree to all, but in a greater degree to Sir William Armstrong's.

4137. Why more to Sir William Armstrong's than to other rifled ordnance?—The vent piece is moveable, and before it is dropped into the gun, a priming is put on its face, and in the upper part of the vent piece, when in its place, another priming is put. On the guns being fired, the action of the elastic fluid goes down straight, and then takes an angle, and fires off the little primer before it communicates with the charge. Then again, the shot is tightly nipped at starting, in fact, it has to wedge itself through a hole smaller than itself. There is also a great amount of cohesion of surface, independent of the wedging action, which cohesion acts throughout the bore. It is not speculation with regard to the cohesion of surface; it is shown by experiment. When the bore is not well lubricated, the range of the shot is considerably less than when it is lubricated with the grease-wad invented by Colonel Boxer; so much so, that in all our tables of ranges the first shot is omitted, on account of this hanging of the lead—this cohesion to the surface of the gun—therefore, from that fact alone, if you were firing the first shot, or firing afterwards with imperfect lubrication, or when the gun was at all leaded, you would have an irregular action, and never would be able to hit an object at sea with any certainty.

4138. That is one objection that you make to the Armstrong gun; can you state whether there were any experiments tried with respect to the slowness or quickness of firing with the Armstrong gun before it was introduced into the naval service?—I am not aware of any.

4139. Mr. *Laird.*] Captain Wainwright was examined before this Committee, and he states that the rifled gun is not so accurate in rough weather as the smooth bore?—Yes.

4140. Captain Wainwright gives this answer, in reply to question 3781: "It is my opinion that it takes so long in quitting the bore, that if there is much motion it must affect the aim, though I am sorry to differ in opinion with Captain Jerningham. The 'Black Prince' is an enormous ship, but she rolls at the rate of six times in a minute on an average, six times to starboard and six times to port." Then he was asked, "Is that in moderate weather?" and he answers, "In moderate weather; and if she is rolling very deep and very heavy at that rate, the gun must be moving over a great many degrees in a second. I cannot imagine any experience being sufficient to enable you to take a good sight with it. The quicker the gun can get rid of its shot the better; it is of the greatest possible importance in taking aim." Do you agree in that opinion with Captain Wainwright?—Perfectly; it is a matter of common sense.

4141. Colonel *Dunne.*] Why, then, is a powder used which does not ignite so rapidly?—If they used a quicker burning powder, the shot at starting would cut its way right out; it would not take the rifling of the guns at all.

4142. But, in fact, they do use a slower burning

ing powder, which is complained of?—Certainly, they have done so.

4143. *Chairman.*] Does the slowness of fire depend more on the quality of the powder which is used than on other considerations?—The slowness of the powder would materially affect it; but there is also the double priming, the nip at starting, and the friction in the bore.

4144. Major *O'Reilly.*] I think you stated that even in the smooth-bore gun a space of time about one second elapses before the shot parts?—Yes; from the pulling of the trigger (not while hanging in the bore) which a man can allow for by practice.

4145. I want to know why, if a man can allow for one second by practice, he cannot allow for two seconds?—Because the time is unequal; and, in the next place, you can allow for the motion of the vessel, but you cannot carry the mind so well forward to the motion of the gun when the shot is retarded.

4146. In the olden time, when men used flint guns in shooting, they always allowed longer than for the percussion lock, and they found no difficulty?—The man was on a fixed platform; but the gun is rolling all this time through space. If you could make the ship roll exactly up and down without any movement right or left, you might do the same; but you cannot carry the mind forward as to which way the ship is moving.

4147. Mr. *Dodson.*] As a matter of fact, have you seen firing with the Armstrong gun at sea at distant objects?—I have seen it at Shoeburyness, but not at sea.

4148. Do you know if the Armstrong gun has been experimented on with the sea rolling?—The guns have been fired comparatively little at sea.

4149. Have they been found to fire accurately or inaccurately?—Inaccurately.

4150. Mr. *Beecroft.*] Was that in smooth water?—Excepting in our harbours, you are never in smooth water; a man accepts the gun as valuable, because it has been so commended; and if he has been put to fire it in smooth water, he is very liable to be mistaken with respect to the qualities of the gun.

4151. Mr. *Laird.*] You have been asked whether there have been any experiments at sea with those guns. At question 3789, Captain Wainwright was asked, "You have said that you approve having those Armstrong guns on board for distant firing," and he replied, "Yes." Then he was asked, "But you say that, in bad weather, the guns are very inaccurate," and he replied, "They are more inaccurate than the smooth-bore, I think." Do you agree in that opinion of Captain Wainwright?—Perfectly.

4152. *Chairman.*] But you have had no experience of the Armstrong guns yourself afloat?—No, I have only seen the gun fired at Shoeburyness.

4153. Will you kindly go to the next point after its slowness of firing?—The want of sufficient velocity of projectile.

4154. That is want of initial velocity?—Yes.

4155. Is that with regard to the principle of penetrating iron plates?—No; that would hold in any fight at sea; the slow velocity necessitates a greater elevation and a more curved line of flight.

4156. Colonel *Dunne.*] The initial velocity of all rifled guns is slower than that of smooth-bored guns, is it not?—Yes.

4157. That is applicable to all rifled guns, is it not?—Not in so great a degree.

4158. But compared with a smooth-bored gun, the rifled gun has always a smaller initial velocity, has it not?—If you shorten your rifled shot you may attain an equal velocity, but with a great deal greater strain upon the gun.

4159. Does not that strain become dangerous to the gun when you obtain that velocity?—Certainly.

4160. Is not the velocity of a rifle ball kept up for a longer time, though the initial velocity is not so great?—Yes.

4161. That is the great distinction between the projectiles of the two guns, is it not?—Certainly; it is one distinction, but not the only great distinction.

4162. Is not the trajectory of a rifle ball much less curved than that of a smooth bore?—No, not at an effective distance, for in naval warfare actions can never be decided between iron-clad ships at distances at which you cannot pierce their plates.

4163. At what distance would you put it?—That would depend on the size of the gun; I think you may do it up to 1,000 yards with the present armour plates.

4164. Has that ever been done?—The Horsfall smooth bore did it at 800 yards.

4165. Could you arm ships with that?—I think so.

4166. What is the weight of it?—Twenty-four tons.

4167. Could you carry more than one gun of that weight in any man-of-war?—Yes; I think you could take five Horsfall guns in a vessel of the size of the "Minotaur," five on each side.

4168. *Chairman.*] Can you show to the Committee that there were other rifled guns than Sir William Armstrong's offering more advantages and greater chances of success than Sir William Armstrong's gun, and which ought to have been tried before the wholesale construction of the Armstrong gun was proceeded with?—I think that any rifle groove would have been better than that adopted by Sir William Armstrong.

4169. That is an objection to Sir William Armstrong's gun; but what I ask is, can you show that there were any other guns that ought to have been experimented on and tried before so large a manufacture of the Armstrong guns was gone into?—Mr. Bastley Britten's and Mr. Jeffrey's guns, firing lead-coated shot, expel the shot with less strain upon the gun.

4170. But Mr. Bastley Britten's and Mr. Jeffrey's guns were known from the year 1853, and they were before the Ordnance Committee, and were tried, were they not?—They cannot be said to have been tried since they were not tried under the same conditions as Sir William Armstrong's guns; they were tried with cast-iron guns.

4171. Mr. *Baring.*] You are speaking of the system of rifling, and not of the gun?—I thought I was asked about the system of rifling.

4172. I understood that you were asked about the gun?—The gun and the rifling are constantly mixed up together.

4173. General *Peel.*] I understand you to say that you are speaking of Sir William Armstrong's gun entirely as a naval gun?—As a naval gun.

4174. Are you aware that the Ordnance Select Committee, of which you have been speaking, never recommended the gun as a naval gun at all?—I am not sure that I understand your question; I am not attacking the Ordnance Select Committee; I am simply giving my opinion in reply to questions asked of me.

4175. But you having stated that you think that

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that the Ordnance Select Committee did not carry out a sufficient number of trials with the different guns before the Armstrong gun was introduced into the Service, let me ask whether you are not aware that they never tried any naval guns at all?—I rather think the words "Ordnance Select Committee" were not used by me, but were put into my mouth when I replied to a question.

4176. You stated that it was early shown that the expenditure on the larger Armstrong guns was injudicious, and I think you will see that it is important to show who was responsible for that expenditure?—I find at page 176 of the Appendix to the Blue Book of last year, these words in the Minutes in the Report of the Special Committee on iron plates and guns: "The Committee approve of the adoption for the Naval Service of Sir William Armstrong's 40-pounder of 32 cwt., 10 feet in length; but propose that it be reduced when necessary to a gun of 30 cwt., with a length of 7 feet 6 inches." I have understood that that Committee was appointed by the War Department; Colonel St. George was President, the President of the present Committee; Captain Wiseman was Vice-President, he being Vice-President of the present Committee. Sir William Armstrong himself was a member, and also Captain Noble, who immediately after the adoption of the Armstrong gun as a field-piece became his partner.

4177. But that Committee was appointed long after the introduction of the Armstrong field gun, was it not; what is the date of that Report of which you have been reading?—The 24th of September 1859.

4178. Was not the other Committee appointed in November 1858, and dissolved long before the Committee from whose Report you have been quoting was appointed?—I do not really see to what the questions of the Honourable Member are pointing.

4179. *Chairman.*] I understand that you do not object to the Armstrong guns as a field gun, but you object to the Armstrong gun of the larger sort as a naval gun?—Yes.

4180. Therefore, any statement which you may have made bears in no way whatever upon the gun adopted by the Committee to which the honourable and gallant Member has just been referring, but bears altogether on the naval gun approved by a subsequent Committee?—I have only spoken of the gun as a naval gun.

4181. *General Peel.*] It was the duty of the Admiralty to select guns for the naval service, was it not?—The Admiralty select the gun that is put before them; if there were no other guns prepared they could not take a gun which had no existence.

4182. But the War Office had nothing to do with the selection of the guns for the Admiralty, had it; they selected the guns on the basis of their own trials, conducted by Captain Hewlett, on board the "Excellent." Will you read the heading of that Minute?—"Minutes of Special Committee on Iron Plates and Guns; 7th Meeting. The Committee assembled at the War Office at 1 p.m., on the 24th of September 1859. Present—Colonel St. George, C.B., R.A., President; Captain Sir W. Wiseman, Bart., R.N., Sir W. Armstrong, C.B., Captain Noble, R.A., the Secretary. The Committee approved of the adoption for the naval service of Sir W. Armstrong's 40-pounder of 32 cwt., 10 feet in length, but propose that it be reduced, when necessary, to a gun of 30 cwt., with a length of seven feet six inches. The Committee were of opinion that the following description of guns should be made to replace the 32-pounder of 56 cwt., and the 68-pounder of 95 cwt, viz., a 100-pounder of 56 cwt., and a 100-pounder of 65 cwt.; the calibre of each of these guns to be seven inches; the length of the former gun to be seven feet 6 inches, and that of the latter 10 feet," and so on.

4183. That is a Special Committee on Iron Plates, is it not?—On Iron Plates and Guns.

4184. *Chairman.*] But still you are aware that the Admiralty would not be obliged to introduce a gun into the naval service unless they approved of the conclusion to which the Committee had arrived?—The Admiralty, it seems to me, are in a difficult position, because they do not supply the guns themselves.

4185. But still it is the Admiralty who make demands upon the War Department for any guns they please, and it is the duty of the War Department to supply those guns; is not that the fact?—Yes.

4186. General *Peel.*] Will you be so good as to read the letter which you will find in page 246 of the Appendix to last year's Report, dated "Admiralty, 17th of January 1859. Sir,—With reference to your letter of the 10th instant, stating that it is in contemplation to make provision in the Estimates for the ensuing year for 40 24-pounders and 40 12-pounders brass howitzers, for the armament of boats, and requesting to be informed whether my Lords would prefer these guns being constructed upon Mr. Armstrong's plan; I am commanded by my Lords Commissioners of the Admiralty to transmit to you herewith, for the information of the Secretary of State for War, a copy of a letter dated the 14th instant, from Captain Hewlett of the "Excellent," stating that it is very desirable that Armstrong guns should be at once introduced for boat service, and for the field-piece carriages that are supplied to Her Majesty's ships; and I am to request that instructions may be given to Mr. Armstrong to construct as powerful a gun of each description as possible, confining himself to the limits, as regards weight and length, of the guns now in use. I am, &c. H. Corry."

4187. Does not that go strongly to prove that it was by desire of the Admiralty that the guns were introduced?—Yes, it speaks of field pieces for boat service.

4188. The Secretary for War having been instructed to take in his Estimates, a certain sum on account of the Admiralty, he applies to the Admiralty to know what the guns are to be, and the Admiralty send instructions as to what the nature of guns is to be. Is not that so?—I am perfectly well acquainted with this blue book of last year. Probably there might be some blame thrown on the Admiralty which would be unmerited, if I did not go fully into the question. I perfectly agree with the first report made by the prior Committee on the Armstrong gun, and you will find that they there put the objections against its introduction very clearly, and very strongly. The page I refer to is page 163.

4189. That was in 1855, before the appointment of the Special Committee, was it not?—Before the appointment of the Special Committee they made a report upon the gun, and that report is the one which I say I entirely agree with.

4190. *Chairman.*]

4190. *Chairman.*] Is that the Report of the 29th November 1855?—Yes, 29th November 1855; and there is a passage which has not yet come out, which I should like to read:—"The leaden projectile, the smallness of its diameter compared with its length, and its consequent inapplicability to ricochet fire, are fatal to its use as a field-piece, where the difficulty of judging the distance, and the rapid change of position, make it difficult to strike the object at the first graze; neither could common or Shrapnel shells be fired from a gun of this pattern." If that objection exist on shore, the gun being in a fixed position, how much more would the objection apply with respect to ricochet firing on board a ship.

4191. General *Peel.*] Will you now refer, at page 247, to the second paragraph of Captain Hewlett's letter, and read it to the Committee?—"I should, therefore, beg to suggest that no unnecessary time should be lost in placing Armstrong's 40-pounders on the upper decks of all vessels, substituting them for the present revolving guns; and that the carriages for these rifled guns should be proceeded with without any delay, so as to be ready for the guns as fast as they can be procured."

4192. Was not that, therefore, on the recommendation of the Admiralty?—Captain Hewlett's recommendation.

4193. What was the position of Captain Hewlett?—He was captain of the "Excellent."

4194. Was that an experimental ship for the Admiralty?—A gunnery ship, and not an experimental ship. There is a great distinction to be drawn in that respect. Captain Hewlett has no opportunity of seeing the whole of the practice, or of getting the reports of failures, and other things that occur. He is only on board the "Excellent," and he has no means of really comparing the rifled gun with others. You will observe he recommends this gun for the upper decks of ships; and you will observe, also, with respect to the rifled gun, that the reports of different officers, who were said to be distinguished, were, "that the gun was wonderful; that it could do everything but speak;" and therefore people were led away. It was a commonly received thing that the gun was wonderful in its effects.

4195. You have stated that it was early shown that the expenditure on the large Armstrong guns for naval purposes was injudicious, and I ask you who it was that was responsible for the continuance of that expenditure?—That is a question that I think I am unable to answer; but I think I can give you a reason why that expenditure took place. The gun was adopted principally by military officers conversant with practice in the field, and it was used principally at target practice at Shoeburyness. Naval officers had scarcely any opportunity of seeing its effects.

4196. You say that it was early shown that the expenditure on these guns was injudicious; if naval officers expressed their objections to the gun, can you state who was responsible for the continuance of the supply of the guns to the navy?—Naval officers did not know enough of it to express an opinion as a body; and you observe here what Sir William Armstrong wrote respecting the gun.

4197. Was not it the duty of the naval officers to report to the Admiralty directly if they were not satisfied with the guns with which they were supplied?—Almost before any trial could be made there was a large number of the guns manufactured.

4198. *Chairman.*] Were there not a very large number of guns ordered before there was any trial at all?—Yes.

4199. Mr. *Baring.*] You have stated that it was early shown that the expenditure on the Armstrong guns was injudicious. The honourable and gallant Member now asks you to give some substantiation of that statement. What may be the date of the experiments against iron plates to which you have referred, as showing that that expenditure was injudicious?—The autumn of August 1860, against the Thornycroft 10-inch bars.

4200. Then your belief that the gun was proved not to be a good naval gun depends on that circumstance entirely, namely, its failure against Mr. Thornycroft's iron plates?—No; the failure of the gun against iron plates, its inefficiency for a broadside gun, and the other conditions to which I have referred.

4201. General *Peel.*] But the gun having been proved unfit, I suppose that the naval officers who had charge of it would report its unfitness to the Admiralty, who were responsible if any further supply were made?—There were a great many guns manufactured before any trials were made; a considerable time must elapse before a man can report decidedly upon a gun, and in the presence of such strong evidence as seemed to exist at that time with respect to its value, men might very much hesitate in taking any direct stand against the Armstrong gun.

4202. The guns having been manufactured would have nothing to do with the question; it having been shown to the Admiralty that the gun was not a proper gun for the service, who was it that was responsible for making any further demand?—There is no other rifled gun at present in the service, and it would be wrong to do altogether without a rifled gun for the purpose of bombarding; but the Admiralty have taken very few of them.

4203. You say that it was early shown that there was a very injudicious expenditure on the larger Armstrong guns after it had been proved that the guns were inefficient; and I now ask you who was responsible for that expenditure?—I think the system was responsible.

4204. Mr. *Laird.*] Do you think that there ought to have been a number of experiments made after those experiments at Shoeburyness in the year 1860, and before a further large expenditure was incurred upon the Armstrong guns?—Yes.

4205. Do you think it would have been more judicious to make experiments with other guns before going on so largely with the Armstrong guns?—Certainly.

4206. But you do not wish to blame the authorities for what they did?—Certainly not.

4207. *Chairman.*] Will you state what guns you think ought to have been tried?—I can state what I think should have been done.

4208. Yes; will you mention what you think it was possible to do, and which was not done by the Government?—Yes; I will take it generally.

4209. General *Peel.*] Of what year are you speaking?—I will take 1860, after the experiments were made against the Thorneycroft-bars. The smooth-bored gun having at 600 yards shown

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its superiority, I think it was very desirable in any rifled-gun that might be introduced, not to give up what was shown to be valuable, and therefore, that any rifled-gun introduced for the navy should have been of the same calibre as the guns then in existence, and should have been able to fire the ammunition which was then used. Had that been the case, there would have been no necessity to go on so fast, or incur any great expense in making rifled-guns for the service, and there would have been no transition state. You would have had your smooth-bore gun, and another gun rifled, which would also have been useable as a good smooth-bore gun. I have already mentioned the first condition, which was, that in any of the trials made we should have kept to the bores of the guns then existing, so that even if the guns had failed as rifled guns, they would still have been fit for firing the round ball, which had then shown its superiority. That was what the French actually did. Experiment has shown that a properly rifled-gun discharges a round ball with greater accuracy than an unrifled-gun.

4210. What gun has that been shown in?—It is stated in the report of the Ordnance Select Committee on competitive rifled cast-iron guns.

4211. General *Peel.*] What is the date of that Report; was it not a paid committee?—Yes; the War Department have just sent the report to me.

4212. It is a recent report?—Yes; and on page 13 there are these words: "The following tables contains the comparative practice in August 1861 with the smooth-bore 32-pounder, and a shallow-groove riffed-gun (Mr. Bashley Britten's), both firing round shot with the service charge of 10 lbs. Elevation by spirit-level, the guns 17 feet above the plane, and the result is, that it is decidedly in favour of the rifled-gun." The Committee add that they have not tried it with any other system, which however is a mistake; for, on my urging them to try it with my gun, they did so on May the 14th, and it was also more accurate than the smooth-bore on that occasion.

4213. *Chairman.*] Your first position is, that the Committee ought to have made experiments between the smooth-bore gun and the Armstrong gun; now, is there any other gun which, in your opinion, they ought also to have tried before they proceeded to call upon the War Department to make so large an expenditure with the Armstrong guns?—I think they ought to have tried the guns which were then before them.

4214. What guns are those?—I am unwilling to mention my own name, and I understood that I was to be examined before this Committee as a naval officer, and therefore I have not touched upon the smaller Armstrong rifled pieces.

4215. The Committee would be very much obliged to you if you would state anything that occurs to you as bearing upon the subject?—Experiments have not been tried up to the present time with other systems of rifling, except with cast-iron guns, and those experiments not under the most favourable conditions.

4216. Mr. *Vivian.*] The date of the Committee was previously to the manufacture of this large number of heavy guns, was it not?—Certainly.

4217. *Chairman.*] Can you state any facts which have come under your own knowledge, which led you to believe that those guns which were not fully tried were worthy of being tried; have any experiments been tried which seem to show that they were likely to be efficient?—Yes.

4218. Will you be so kind as to state the results of any experiments that were made with those guns?—The initial velocity of the whole was, without exception, greater than that of the Armstrong service gun.

4219. Mr. *Baring.*] Can you state the comparative charges of powder, and weight of the projectiles?—I will take Mr. Bashley Britten's gun; that gun was fired with a five pound charge of powder, and the weight of the shot was 48 lb.; the initial velocity was higher than that of Sir William Armstrong's 40-pounder.

4220. What was the charge of powder?—The same charge; Mr. Britten's gun is the old smooth-bore 32-pounder gun rifled.

4221. *Chairman.*] And what was its range?—Its range up to five degrees was about equal to the Armstrong 40-pounder.

4222. When were those experiments tried?—Mr. Bashley Britten's gun was tried in 1859. Mr. Jeffery's gun was tried considerably before that, and the result was similar.

4223. And that is one instance in which you say that there were reasonable grounds for leading the authorities to the conclusion, that that gun ought to have been tried further before a large expenditure was incurred with respect to any other gun?—Yes, that of Mr. Bashley Britten's gun; Mr. Jeffery's gun was prior to that.

4224. What was the weight of the projectile, and the charge of powder, of Mr. Bashley Britten's gun?—The charge he has fired with lately is less; the charge of powder was 6 lb., but is now 5 lbs., and the weight of the projectile is 48·96, the initial velocity given for Mr. Bashley Britten's gun is 1213·5, with a charge of a 10th. The initial velocity of the Armstrong gun as compared with that was about 1,200.

4225. Mr. *Baring.*] Is that in the same table?—No.

4226. Then where do you obtain the initial velocity of the Armstrong gun?—Sir William Armstrong states his own initial velocity at 1,200 feet in a second. He says that, in answer to question 320, in the Report of the Defence Commissioners, "What velocity do you consider you should look to as the proper initial velocity?—1,200 feet. With elongated shot?—Yes."

4227. You do not compare the initial velocity of Mr. Bashley Britten's gun, with the actual initial velocity of Sir William Armstrong's, as given in any report of the Ordnance Select Committee, but with something else?—I have the printed paper here.

4228. Surely the proper way would be to compare the actual initial velocity of one gun with that of another?—Mr. Bashley Britten's gun was the old cast-iron gun, and this gun of Sir William Armstrong's was a new service gun.

4229. But in making a comparison, do you not think it is the fair way to make it on actual experiments upon the two guns, made under the same circumstances?—I consider what I have done is fair in this case; one was the old smooth-bored gun, costing about 60 *l.*, which was at once, with little expenditure, brought to fire rifle shot up to the distance necessary for effective warfare (according to Sir William Armstrong), and showed that it actually was more effective than the 40-pounder Armstrong gun, which cost about eight times as much.

4230. Of course, in that comparison, you assume

sume that the efficiency of one gun is proved against the other, but I do not assume that: and my question is, whether the proper way of comparing the effect of one gun with that of another, with regard to the initial velocity, is not to make actual experiments with the two guns under the same conditions?—There are several actual experiments with the 40-pounder, the tables of which the Commitee can obtain.

4231. Will you refer us to any reports of the Ordnance Select Committee which are before this Committee, showing the result of experiments with 40-pounder Armstrong guns under the same circumstances as those guns to which you have just referred?—There has been a table sent to the Admiralty by the Ordnance Select Committee; and if you call for that table, you will have the experiments before you.

4232. Showing the charge of powder, and the weight of the shot, and so on?—Yes; the weight of the gun is another thing. I believe that I was to be examined with respect to the advisability of the expenditure which has taken place upon the Armstrong gun; and I show that a cast-iron gun at that time was, with a charge of one-tenth, giving a higher initial velocity than the Armstrong gun with the charge of one-eighth.

4233. You say, that among those guns tried by the Ordnance Select Committee, Mr. Bashley Britten's gun gave, as you consider, better results with respect to initial velocity than the Armstrong gun?—No, I do not "consider"; it is a matter of fact.

4234. It is a matter of fact, although the comparison was not made?—The comparison is made, and the tables are published. I have quoted Sir William Armstrong's own words; and I can quote Sir William Armstrong's own words, with respect to his initial velocity, on another occasion, which words I think are conclusive.

4235. Is there not a comparison of the charge of one-tenth in both cases, in the table in the Blue Book to which you have been referring?—The Armstrong 40-pounder gave an initial velocity of 1197·5.

4236. *Chairman.*] On what authority do you make that statement?—On that of the Ordnance Select Committee's report. The strength of the powder was, I perceive, considerably greater than in the former case; the strength of the powder in the case of this 40-pounder was 1248, and the strength of the powder in the case of Mr. Bashley Britten's gun was 1170.

4237. Mr. *Laird.*] What was the initial velocity in the other case?—It was 1213·5 in the case of Mr. Bashley Britten's gun.

4238. *Chairman.*] And the date of the experiment?—The Committee do not give the date.

4239. Mr. *Vivian.*] And the charge of the powder, and the weight of the projectile were, what?—One-tenth of the projectile's weight.

4240. Mr. *Baring.*] Why do you take the last case to which you have referred, instead of the next one with reference to the Armstrong gun?—My reason was that simply I did not see it; the next case gives 1227·3 as the initial velocity.

4241. That is greater than the other?—Yes, because the powder is stronger.

4242. What are the proportions of the strength?—1248 to 1170.

4243. What difference does that make in the calculation?—I can hardly tell without knowing what particular conditions there might be, because the firing of one only gives an initial velocity of 1076·2.

4244. Mr. *Laird.*] Whose gun is that?—It is an Armstrong gun.

4245. Then, what is the next?—That is more than 100 feet lower than the one before. The initial velocity is not given, but I will work it back in a moment. [*The Witness made a calculation.*) I find that that would give very nearly 1094 initial velocity for the Armstrong 40-pounder.

4246. Mr. *Baring.*] The last experiment is with 4 lbs. of powder, is it not?—Yes; but this requires a good deal of minute looking at to observe.

4247. Then, will you be kind enough to state all that in a paper afterwards, when you have looked at it more minutely?—I will do so.

4248. Mr. *Vivian.*] Casting my eye hastily over that report of the Ordnance Select Committee which you have produced, I thought I saw a passage in which the Committee say, that they rejected both Mr. Britten's and Mr. Jeffery's gun. Will you be kind enough to explain on what grounds that rejection took place?—No, that is not so. They rejected Mr. Jeffery's projectiles as requiring one-fourth more lead than Mr. Bashley Britten's, and holding less powder, and the mode of attachment being less simple.

4249. What do they say with respect to Mr. Bashley Britten's?—As to Mr. Bashley Britten's system, they had no hesitation in awarding the first place to Mr. Britten on account of the little comparative strain on the gun with the moderate charge which he advocates.

4250. Do you know at all why the investigation with Mr. Bashley Britten's guns did not proceed?—It is going forward at the present time. There are some rifled guns to be made now, for the purpose of testing the following systems:—Mr. Bashley Britten's, Mr. Jeffrey's, Mr. Lancaster's, and Commander Scott's.

4251. By whom are those experiments being made?—By the Ordnance Select Committee.

4252. But Mr. Bashley Britten's system having been to a certain extent approved of, do you know why they did not proceed at once to investigate it by experiments on a large scale?—I can only conceive a reason, which was an endeavour to make some plan of Sir William Armstrong's successful, and therefore that others who brought forward systems of rifling were delayed.

4253. But Mr. Bashley Britten's system would have been comparatively a very inexpensive one, would it not?—Yes.

4254. General *Peel.*] When you speak of endeavouring to make some plan of Sir William Armstrong's successful, to whom do you intend that to apply?—I imagine that Sir William Armstrong, as being Director of Rifled Ordnance, had a special power over the experiments as the adviser to the War Department, and I imagined that unless he advised a thing they would not make the trial.

4255. Is that only your imagination?—I am only speaking of their not trying the other systems of rifling described in this Report.

4256. I thought they did try them?—No, they are going to do so now; there were trials only with cast-iron guns.

4257. Am I to understand you to say that this Committee had such a prejudice against other inventors than Sir William Armstrong that they did not go into the trials of other guns?—I do not say that, whatever I may think about it.

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4258. That Committee was appointed by the Government and paid by the Government for that special duty, and had no more to do with Sir William Armstrong than they had to do with any other inventor; was not that so?—One is always placed in a difficult position if one speaks what one conceives to be the exact truth; I believe the President and the Vice-President of the Select Committee had advocated the gun, and therefore they tried, as men naturally would, to make the system successful; I can only account for their not trying other guns in that way: I think that a man may have an honest but an unperceived bias, and that a great many people have such a bias.

4259. Mr. *Laird.*] Was Sir William Armstrong Engineer of Rifled Ordnance?—Yes.

4260. If he had failed in his own invention, is it likely that he would have recommended the adoption or trial of any other gun?—Certainly not.

4261. Must he not have had from his position great influence with that Committee as an adviser?—Certainly.

4262. General *Peel.*] Who was it that submitted the guns to the Committee for trial; was it not the Secretary of State for War?—Yes; he sent the letter down; it was a mere matter of form; he sent the letter to the Committee to report upon.

4263. Do you know from your own personal knowledge that Sir William Armstrong was ever consulted with regard to any gun that was ever submitted to that Committee?—It is impossible to tell what passed between Sir William Armstrong and the War Department.

4264. Mr. *Vivian.*] But you have this fact before you, that certain other guns were tried in 1859, and that from that time forward no extensive or efficient experiments were made with the view of testing the real value of those guns?—Certainly; there have been none up to the present time.

4265. Those experiments were made at that time with cast-iron guns; cast-iron is well known to be an improper material for the manufacture of rifled ordnance?—Certainly.

4266. Then what you state to the Committee is this; the Government had the means of making a gun which would stand rifling, but nevertheless, from the year 1859 down to the present time, the Government have never caused to be made a rifled gun upon any other system than the system of Sir William Armstrong, in order to test the value of any different system of rifling?—That is precisely what I mean.

4267. But you are not aware where the fault lies with any particular department of the Government?—I think that it is the system; and in the case of the naval guns, the reason of the failure is, that naval men were not on the Committee, or at least that they were very few in number. I think that there was only one naval man on the Committee.

4268. Are you aware that the Ordnance Select Committee are not empowered to originate any trial of any particular gun?—I understand that they are not empowered to originate trials.

4269. Therefore, the fault of the non-origination of any trial would not lie at the door of the Ordnance Select Committee?—Certainly not.

4270. Probably you are not aware which department of the Government ought to originate trials, or arrangements for trials, you never having been employed in Government offices?—I can only say with respect to that subject, that I think as I have said before, the plan of having military men to decide upon naval guns is not likely to be attended with success.

4271. But, with respect to originating experiments with guns, you have no knowledge as to what department of the Government ought to originate such experiments, have you?—No, I have not.

4272. There may be no department of the Government which ought to originate such experiments?—Possibly not.

4273. And probably that is the case?—I think very probably.

4274. Captain *Jervis.*] Upon what foundation do you make the statement that there is no department of the Government whose duty it is to originate experiments with guns?—I have not said positively that there is no such department; I say that I do not know of any.

4275. Taking the very case of your own gun; do you know how the question of experiments with that gun arose?—I submitted a letter to the War Department, and the War Department sent it to the Ordnance Select Committee, and the Select Committee reported that they were going to make trials with a similar gun, and so it was at first negatived.

4276. Was not it your proposal, along with some others, that you should rifle cast-iron guns so as to prevent the expense of wrought-iron guns?—Yes, but I intended to make the rifling supplementary to smooth-bore firing; to fire a rifle ball with a very small charge.

4277. But have you not repeatedly brought to the notice of the War Department your opinion, and also lectured at the Royal Institution of Civil Engineers, in support of that opinion, that a cast-iron gun could be properly rifled?—Yes.

4278. Therefore, you had not got the idea at that time, that a cast-iron gun was an improper thing to try, had you?—Certainly not; it was the proper thing to commence the trials with, but not to go on with them with.

4279. But was it not your own proposition that there was no necessity for rifling wrought iron guns, cast-iron guns being sufficient?—No, certainly not.

4280. Then what was your proposition?—I will read it: "Method of rifling iron and brass muzzle and breach loading guns so as to fire common round shot without impairing their accuracy or injuring the guns, which may be spunged and loaded with as much facility as smooth-bore guns."

4281. Was not that with the view of making use of the guns then in the service?—Yes.

4282. And those were cast-iron guns?—Yes.

4283. The trials began in 1859 and finished at the end of 1862, or the beginning of 1863, did they not?—It is very difficult to say precisely when they commenced or finished.

4284. During three years experiments were carried on in order to enable those who wished to prove the case of cast-iron guns to give them a fair trial?—The case of the cast-iron gun is a perfectly distinct question from the question of rifled ordnance generally.

4285. I am alluding, however, to the question of cast-iron guns?—I think that we were deceived with respect to the strength of cast-iron guns; the strength of the powder had been increased, and we did not at first take that into consideration; most people were under the impression that cast-iron would stand; for instance, the Ordnance Select

Select Committee rejected Mr. Whitworth's system, because a cast-iron gun burst.

4286. Are you now satisfied that a cast-iron gun will not do with your system of rifling?—It will do as well as with any other system; you cannot get great results out of a weak material; but you can get certain results out of it. The Prussians use cast-iron, and get results of a certain value out of it.

4287. But as far as our own service is concerned, the results of those experiments prove that cast iron is not the proper material for rifled guns, is not that so?—It is not so good a material as what we know of at present, for you have Krupp's metal, which has stood perfectly well. You have several solid guns of this; and you have the steel gun of Mr. Naylor Vicars, which has stood all the tests that have been applied to it.

4288. Do you consider that the report is unfair in which the Committee say that they consider that cast iron is not a sufficiently durable material for a rifled gun?—They do not recommend it at the present time; in the earlier stage of the affair it was advisable to try whether cast iron could not be made available before going into the manufacture of the Armstrong guns. Having now made all those experiments, and found out another material which is better, it would be folly to go back again to the old position.

4289. Then it appears that the Government some years ago formed the determination, and came to the conclusion which you have now come to, namely, that cast iron was not a proper material from which to make rifled guns; that is to say, you have found out in 1863 what the Government had done in 1856?—I do not think that that is a very fair way of putting it, because the Government could only arrive at the conclusion by actual experiment; otherwise the fact would be that they jumped at the conclusion.

4289*. But supposing they did jump at the conclusion, there was surely no blame attaching to them if that conclusion was afterwards found to be correct?—I do not blame the Government; but if any person had done so, I think it would be said that he was rash, and was throwing away money if the experiment did not succeed.

4290. But as a great many persons thought that the experiment would succeed, it was surely only fair to give them a chance of trying?—In the whole of my letters, I have been asking for a strong gun, "a strong gun," "a strong gun." I thought cast iron was good up to a certain point, but I never thought it would be the material which should be ultimately employed; in fact I proposed to the Select Committee to strengthen the cast iron guns for rifling.

4291. Are you aware that experiments with cast-iron, strengthened, have also failed?—I think that, possibly, it might in a measure succeed.

4292. And it might in a measure fail; but still you are not aware of its having succeeded?—I am not aware of the thing having been tried under the conditions necessary to ensure success, and I will give you my reasons for that opinion. They have tried to strengthen the guns with brass, and we know that casting brass upon cast-iron burns the metal; and, secondly, that the brass has no elasticity; the cast-iron must go before the brass could bear any strain. Then they tried it with wrought-iron; but wrought-iron, we know, expands much more readily than cast-iron, and it stretches so that though the guns may be strong while a few charges are fired at the first, the wrought-iron hoops become loose by degrees, and the gun goes; but they have not tried it with a rigid material, such as steel.

4293. General *Peel.*] You stated in answer to the honourable Member for Glamorganshire that your complaint was that the Government having a gun of their own, did not rifle such a gun according to your principle, and that they did not try the guns under the conditions of equal fairness?—What I say is not a complaint; but you ask me for answers to certain questions, and I tell you the truth.

4294. I understand you to say that you think the Government did possess a gun which had a superiority over those guns which were tried at the time of the trials that have been referred to?—I do not say that; because they have never thoroughly tried it.

4295. The gun which the Government possessed was Sir William Armstrong's, was it not, speaking of guns independent of the systems of rifling?—That is a different question.

4296. Mr. *Baring.*] This Report of the Ordnance Select Committee, from which you have quoted, is a Report of a Committee which sat in consequence of Lord Herbert's directions, that they should make trials of all the different plans proposed to the Government for rifling the existing stock of cast-iron guns, is not that so?—I believe so.

4297. Therefore the Committee was not appointed or directed to consider different systems of rifling, but simply to consider the question of the best mode of making use of the stock of cast-iron guns then in the service, and making them into rifled guns; these were distinctly the orders to the Committee, were they not?—I understand so.

4298. The Committee having made trials of different systems, your own among the rest, came to certain conclusions, and made a certain report?—Yes.

4299. Do you object to the manner in which the Committee carried on their investigations, or do you think the investigations were not conducted fairly?—"Fairly," is a word that I do not wish to use; but my letters show that I strongly objected to the manner in which it was carried on; for instance, they were called competitive trials; but the guns were not brought together till the latter part of the investigation; my gun had fired 300 rounds; some of the other guns had only fired a few rounds. I said, "Allow me to have a new gun rifled, and let us all be on an equal footing." Again, I said, "My projectiles are not properly planed, therefore, let me have the best finished projectile possible, before the projectiles are put into competition."

4300. You think, then, that, in these trials, there were certain points in which your suggestions should have been complied with?—Yes. I am not speaking with respect to cast-iron guns; I speak of the value of the conclusions of the Committee with respect to rifling.

4301. But I am confining myself exclusively to the special object of the Committee; do you say that you think your suggestions were not complied with in reference to that specific object?—With respect to the making of cast-iron guns available, I do not object to their report at all; certainly not.

4302. And that is precisely what I am referring to. I ask, have you any objection to the manner in which the Committee reported upon the subject upon which the late Lord Herbert desired them

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them to report, that is to say, the different plans which were for making cast-iron guns available as rifled guns for her Majesty's service? — I object to it in one sense; I do not in another. I do not object to that report with respect to cast-iron for guns.

4303. You object to the report as far as it respects yourself; is that what you say?—With respect to the rifling.

4304. But I wish to confine you to the question of your own plan of making cast-iron guns fit for the service?—The report of that Committee has come out at a time when the necessity for rifling cast-iron guns no longer exists.

4305. You will perceive that I wish to know simply and frankly from you whether you object to the conclusion to which the Committee came with respect to your system of making cast-iron guns fit for the service. Do you say that that was fairly come to or not?—My proposal was in 1859.

4306. It was all in 1859, was it not?—The condition of things is different in 1863. I now quite agree that it would be very unadvisable to try to do it; but if you ask me whether I am satisfied with respect to the trial of my gun as a rifled gun, I say that I am not.

4307. Mr. *Dodson.*] I understand you to say that you agreed to the report so far as it concerns the material of cast iron?—Yes, as it applies to the present time.

4308. But you do not agree to the report with respect to rifling?—No.

4309. Mr. *Baring.*] But the Committee was not appointed to inquire into systems of rifling, was it?—It was the same Committee which inquired into questions of rifling.

4310. But this report does not meddle with systems of rifling, does it?—Yes, it does.

Lunæ, 15° *die Junii*, 1863.

MEMBERS PRESENT:

Mr. Baring.	Mr. Laird.
Mr. Beecroft.	Mr. Monsell.
Mr. Dodson.	Major O'Reilly.
Colonel Dunne.	General Peel.
Marquis of Hartington.	Sir Morton Peto.
Captain Jervis.	Sir Frederic Smith.

THE RIGHT HON. WILLIAM MONSELL, IN THE CHAIR.

CAPTAIN ROBERT A. E. SCOTT, R.N., called in; and further Examined.

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4311. *Chairman.*] HAVE you any remarks to make with regard to the evidence which you gave on the last day when you appeared before the Committee?—Yes, if you will allow me. One of the Honourable Members had asked me whether I had not lectured on cast-iron guns; he will find that my chief object was to avoid the state of transition which must necessarily ensue from adopting a system of rifling, which would not admit of using the existing guns and ammunition; a system which was likewise not only wrong in principle, but also eminently unsuited for naval warfare. My apparent acquiescence in the statement, that the authorities had adopted four years since—what I now thought best—might have produced an impression that I considered the coil manufacture superior to all other modes of making guns; whereas in my lectures in 1860 and 1861, referred to, I pointed out their defects in principle, and merely reserved the expression of this opinion until I might, if considered necessary, be questioned respecting the best materials for rifled guns. I may add that the authorities are even now trying experiments in order to see whether cast-iron guns can be strengthened or not. With respect to the other observations that I made on the reports of artillery officers, which tended to cause the hasty adoption of the gun, I beg to refer the Committee to page 254 in the Appendix of their Report of last year. I find it there stated, "Every requirement in the science of projectiles, which as an artillerist, I have ever wished for, is fulfilled by the gun invented by Mr. Armstrong." That is signed, William Brereton, Major-General. Our being behind our neighbours with regard to rifled artillery, therefore, fully justified an extended and complete trial of the field guns on service, as the expense would be of a limited character; but I did not mean to imply that I considered their enlarged and continuous manufacture was a judicious outlay of the public money. On the contrary, it will be found, on reference to those lectures, which the Honourable Member noticed as given by me, that after the reports from China had reached home, I pointed out, both from private sources of information, and also showed by those very reports, that the Armstrong artillery was far from being a great success, and that its efficiency was very disproportionate to the expense of guns, projectiles, and fuzes; but having then a vast plant, there was a great difficulty in stopping the manufacture. Respecting my observations with regard to Sir William Armstrong's plans being urged forward, and those of other inventors being differently treated, I may be permitted to quote, incidentally, Colonel Lefroy's evidence in this same blue book, which I have referred to, at page 15 question 354: "Do you consider that Mr. Whitworth has had the same opportunity of having experiments tried with regard to his guns that Sir William Armstrong has had with regard to his?—No; I think not." "Why is that?—Because Sir William Armstrong is the Engineer for Rifling Ordnance to the Government. The Government has adopted deliberately his system of rifling, and is bound to work it out." That this has been done is practically illustrated by the fact of the numerous plans and modifications and the very extensive course of experiments which have been tried with the various systems brought forward by Sir W. Armstrong, whilst other inventors have made little or no progress. I may state that the Report of the Ordnance Select Committee, which I objected to the other day, only reached me on the 1st inst.; it does not take in the question of rifling brass ordnance, which I have constantly stated should be at once considered, and I proposed it in 1859. Now, if you will kindly turn to page 8 of the Ordnance Select Committee's Report, you will see that I made an error last time, and gave the Armstrong gun credit for too high a velocity; and that, in fact, a charge of one-tenth the weight of the projectile only gives a velocity of 1,081 yards, the higher velocities named by me the other day being with the service charge of one-eighth, but yet, with these charges of one-eighth, yielding a less result than Mr. Bashley Britten's gun with a charge of one-tenth. This will be more clearly established by referring to page 269 in the Report of last year. You will find there that the range of the Armstrong 40-pounder land service gun, which is the gun compared by the Committee with the rifled cast-iron 32-pounders, is given as 1,164·4, with

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with its service charge of one-eighth. I was asked last Thursday whether I was satisfied with the Ordnance Select Committee's Report, and I may say it was my intention when I first entered this room not to be led to touch upon my own plans, or find fault with the Report, but I think it just to myself, especially as I have since understood that the Report would be printed with the proceedings of this Committee, to mention that I never should have succeeded in obtaining even the late imperfect trial of my system of rifling but for the Admiralty, and as it will enable me to show what part the Admiralty have taken in the introduction of the Armstrong gun respecting which I was questioned, I will endeavour to make the matter clear to the Committee.

4312. I presume there can be no doubt about the fact that the Admiralty adopted the Armstrong gun; nobody could force them to take the gun if they did not choose to take it?—The evidence before you from Colonel Lefroy shows that the gun was put before the Admiralty; and that they had no other gun to take.

4313. Then they took the gun; you surely do not question that the Admiralty deliberately and with perfect knowledge of what they were doing called upon the War Department to provide a large number of those guns?—Two or three of the letters which relate to the part taken by the Admiralty were read the other day, but I will now only read the last of them, merely stating that I laid plans of rifling before the Admiralty in July 1859, and was informed that the question was in the hands of the Select Committee. In August 1859 I proposed my system to the War Department, and a gun was granted me, because (as that Committee states), of my importunity. I may mention that it was very early objected to me, and their Secretary, Colonel Lefroy, said so more than once, that I was not an eminent engineer; and I had to pay my own expenses through not being one, and from having got a gun merely on account of my own importunity. In March 1860, the gun was tried, and in the same month the Admiralty appointed me to the "Fisguard," to assist in developing my plans, and subsequently wrote to the War Department for a new cast-iron gun for me. In July 1860 the old cast-iron gun burst when firing 7 lb. charges (having previously fired 7½ lbs. at 10 degrees of elevation), after 78 rounds. Round balls also were fired from it on the 14th May 1860, yet both this fact and the ranges obtained on that day are omitted in this Report of the Ordnance Select Committee, except the three last, at 10 degrees elevation, which are not (to use the Committee's language) "strictly comparable." Indeed, far from it, for the greater range was obtained with a wooden bottom, thickly felted and greased, which was affixed to the shell, so as to stop windage, and the lesser range was obtained by a shell fired without any wad or lubrication. It was an experiment of mine to see what range could be obtained, under these different conditions at high elevations. I will now read a letter from the Admiralty, dated the 5th of December 1860, subsequently to the firing of my gun. It is to be found at page 248 of last year's Appendix. "At the commencement of June last no Armstrong 40-pounder guns had been received, and on the 5th of that month 40 40-pounders were demanded for exercise, &c. at Portsmouth and Devonport, of which only six have as yet been received. Of the 100-pounder Armstrong guns demanded no portion has as yet been supplied. With regard to future demands, my Lords have great difficulty in stating the exact number of 100-pounders which they would wish to have delivered in the course of the ensuing year, as they have not yet received one of the guns with which to make experiments as to its efficiency as a broadside gun; and until the comparative merits of breech-loading and muzzle-loading guns shall have been tried they are not able to decide upon the description of gun that will be required for broadside guns. They can, however, now state that in addition to the 100 40-pounder Armstrong guns already asked for they will be prepared to take in the ensuing year 100 more 40-pounders, and that so soon as they shall have had a few weeks' experience of the 100-pounder Armstrong gun, and of the 80-pounder Whitworth gun, they will be ready to state more explicitly their future requirements. My Lords must defer their application for 70-pounder Armstrong guns, suggested in a former letter from your Department, until they shall have received a supply of the several guns previously asked for."

4314. Does not that prove that the whole thing depends entirely on the Admiralty, that they had it absolutely in their own power to demand what guns they pleased, and that the War Department were bound to produce those guns?—I hope, in justice to my representation, you will permit me to refer to some evidence which certainly seems strongly to favour the opinion which I hold as to the Admiralty's position with respect to the Armstrong guns, for up to the present day, that question between the muzzle-loader and the breech-loader has not been decided.

4315. Captain *Jervis.*] I suppose you are aware that that question has been going on for the last 300 years and upwards?—I know it has; but I wish also to refer to the 12th page of last year's evidence, question 269: "On whose recommendation was the gun adopted into the naval service; was it upon the report of this Committee? Upon the report of the Committee, that it was a proper gun to be used, and the decision of the Lords of the Admiralty that they wanted such a gun." Question 270: "You do not refer to this Special Committee?—No, it was long subsequently to that." Question 271: "Then did another Committee report upon that gun?—The Ordnance Select Committee reported upon it as a naval gun."

4316. *Chairman.*] But still, ultimately, the decision rested with the Admiralty; the Ordnance Select Committee were a body appointed to try experiments and make recommendations; but the War Department had no power to force the gun on the Admiralty?—If there is no other gun brought forward the Admiralty would be wrong not to accept the gun for the purpose of firing shell. Nobody attempts to prove that a rifled gun of almost any kind is not valuable under certain circumstances, and the captain of a vessel would be very wrong if he did not ask for some such guns.

4317. General *Peel.*] The Admiralty would not furnish the navy with any gun unless they made a requisition for it, and specified the kind of gun that they wanted?—The Admiralty do not try the guns themselves; they can only ask for the guns which are at the time being made by the War Department.

4318. Surely it was on the report of Captain Hewlett's

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Hewlett's experiments on board the "Excellent" that the Admiralty demanded those guns?—They can only try things which are before them. As to saying that when only one gun is tried, that it is the best gun, you might just as well say that a horse was the finest horse in the world when you had galloped it round the course, and there was no other horse run against it.

4319. Sir *Frederic Smith.*] You think that there were no means of comparing that gun with any other gun of the same quality?—None whatever.

4320. And you think that that gun was too hastily adopted?—I have no doubt of it.

4321. But you will admit, I suppose, that there is no better gun to be had at home or abroad?—I understand at the present time, and I have heard Sir William Armstrong state himself, that he prefers his shunt rifled gun; therefore we have a second, best gun.

4322. *Chairman.*] Are you aware that two of the Committee that decided upon the Armstrong gun were appointed by the Admiralty. Sir William Wiseman and Brevet Major Wemyss, of the Royal Marine Artillery?—That was an early Committee.

4323. Which decided in favour of introducing the Armstrong gun into the land service?—Yes, but the second Committee decided upon the Armstrong as a naval gun; the same Committee, in whose Report, my range with round ball, and their having had such experiments at all, with my rifled gun, was entirely omitted. Now, it might appear at first sight as if the omission were of little consequence; but as affecting the value of my opinions on Ordnance, it is of very great consequence; because I had advocated the use of round ball as inseparable from naval warfare, and stated publicly in lectures, that the inability of the Armstrong to fire them was alone sufficient to condemn the gun, and moreover had written to the War Department, on asking for a second gun, on 2d December 1859, saying, "Round shot will always finish naval actions." And these views are now becoming general.

4324. Sir *Frederick Smith.*] On what occasion was it that you made that statement?—On 2d December 1859, to the War Department, and officially to the Admiralty on June 4th 1860. But perhaps the Committee will again allow me to refer to page 15 of the Report of the Ordnance Select Committee on competitive rifled cast-iron guns, article 24. If you will look at the 24th paragraph, you will find these words: "Commander Scott has contended that the guns were originally badly bored, and were badly rifled. The Committee, on full inquiry, believe that there is no sufficient ground for this complaint; but, if well founded, it tends to show that this system requires greater nicety than other systems, which is a disadvantage in a proposal to convert smooth-bored guns." Again, they say, "Much stress is laid by Commander Scott on an alleged straightness of ricochet peculiar to his projectiles. The Committee do not consider this property to be one of much importance."

4325. Captain *Jervis.*] Will you kindly follow that up?—"If even an advantage in this respect could be clearly established." They first say that they did not consider it of much importance; and then they do not wish even to allow me that advantage; but the first part of their Report says, "Commander Scott has contended that the guns were originally badly bored, and were badly rifled. The Committee, on full inquiry, believe that there is no sufficient ground for this complaint; but, if well founded, it tends to show that this system requires greater nicety than other systems." Now I will merely turn to their own letter on the subject, dated the 14th April 1860, to show that they did admit then the inaccuracy complained of, for the Secretary writes, "I am directed to inform you that the Committee will not object to the completion of the experiment with your short shells, since you so strongly desire it, before taking any steps to rectify the bore and the rifling of the gun, which will now depend upon the result of this trial." In a previous letter it is stated that they are ready to rectify the bore and the rifling of the gun; but on my stating that if they bored the gun out, and then re-rifled it, the shot which I had made at my own expense would be too small, they say they do not object to proceed to the completion of the experiments before "rectifying the bore and rifling."

4326. Captain *Jervis.*] Those experiments were especially with regard to cast-iron guns, were they not?—Yes, I think so.

4327. And you asked to be allowed to be a competitor?—No; the Committee say that I was merely included for convenience.

4328. And in the middle of 1860 they wrote to say that they allow you to have a second gun made?—Yes; because I said that the first gun was badly bored and rifled, which they do not, however, now admit.

4329. But they also say, do they not, that you did not send in any shot at all?—There is nothing of the kind in that Report. My letter of the 6th of February 1860 objects to the bore and the grooving of the gun. The crookedness was visible to the eye, but I suppose the Select Committee did not look.

4330. *Chairman.*] But what is the precise point that you want to establish before this Committee?—That there have been no sufficient experiments with regard to systems of rifling at all; that they have been carried out under unequal conditions altogether, and that there has been no opportunity permitted of testing any system but the fine-grooved rifling of Sir William Armstrong, and his later shunt system.

4331. Captain *Jervis.*] You have stated that you were included in the list of competitors for convenience; the Ordnance Select Committee's Report says, "Commander Scott was not among the gentlemen originally invited to rifle a gun for trial, but having obtained permission in November 1859 to have a service 32-pounder rifled at his own expense in the Royal Gun Factories, and subsequently a second gun which has been tried concurrently with the others, he is here, for convenience, included in the list," that is to say, included in the list for this report. Then with regard to your having no shot or shell, the report says, "The first 32-pounder rifled for Commander Scott, No. 9,029, burst on 17th July 1860, before that officer had settled the form or weight of his projectile or his charge, and another gun was allowed to be rifled for him," is that correct?—That is not a fair way of putting it, because all of us gain a little by experience. The fact was this,—the rifling of my gun was performed with Mr. Britten's bar, which had a low twist, for his shorter leaded shot, and having to pay for the rifling, and the making of the shell, I should have had to pay 60*l.* more for a new rifling bar if

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if I had taken a twist which was sufficient; I therefore took a twist which was not sufficient; the second gun was rifled precisely like the first.

4332. *Chairman.*] What was the second gun?—It was a cast-iron gun.

4333. Was that made at your own expense?—Yes, it was to be rifled at my own expense.

4334. Captain *Jervis.*] On the 17th July 1860, had you settled the form or weight of the projectile, or the charge that you wished to have used?—Certainly; because they were trying experiments at that very time with the gun and projectiles.

4335. Therefore the Report of the Select Committee is incorrect when they say you had not settled it?—It was settled at that time; but subsequent experience may enable you to modify your ideas. After completing 300 rounds, with about 46 shells, which were re-fired, on the average six times each; and finding them uninjured, I made the new shell rather thinner and a little longer, so as to hold more powder.

4336. That is to say, you had not settled their form and weight. But referring you again to the words of the Committee, "Much stress is laid by Commander Scott on an alleged straightness of ricochet peculiar to his projectiles; but the Committee do not consider this property to be one of much importance, if even an advantage in this respect could be clearly established." I think you will admit that that relates not to ricochet absolutely, but to the straightness of ricochet?—Yes; but as the report from Shoeburyness states that those shells, at low angles, did ricochet pretty straight, could not the Select Committee ascertain whether they did so or not?

4337. But the effect of your previous statement was not to give the Report of the Committee as it stood, was it?—They had the facts before them, and they could have positively said whether the ricochet was straight or not.

4338. *Chairman.*] As far as I understand you, the point to which you direct the attention of the Committee is that in your opinion that Committee did not give fair play to the guns that were opposed to Sir William Armstrong's?—Yes, certainly.

4339. Captain *Jervis.*] Do not the Ordnance Select Committee condemn Sir William Armstrong's system of rifling cast-iron guns as well as your own?—They condemn the cast-iron gun as too weak; but they do not condemn his shunt system of rifling.

4340. But what question were they called upon to try?—They were called upon to inquire whether cast-iron guns could be rifled, and they gave the palm to Mr. Bashley Britten's plan; but said they did not recommend it.

4341. Although you say they were all endeavouring to give the palm to Sir William Armstrong; he was a competitor at the same time as Mr. Bashley Britten and yourself, was he not?—He was put down in the list as a competitor, but he had superior advantages. At the very time of the trial I saw him between the stops in the firing, setting up the strips on his shot. The Report states that the French gun and the shunt gun are more accurate than Mr. Bashley Britten's, and the guns of the other competitors. I have copies of diagrams here, and I now produce them to the Committee (*producing the same, vide Appendix*).

4342. Are not the diagrams correctly given in that report?—I have taken them from the Report.

4343. Mr. *Baring.*] In the cases referred to in your diagram are there the same number of shots?—They vary in number, but they are all there.

4344. But I ask you whether a comparison for accuracy of fire when you take two shots of one gun with four shots of another gun is of the slightest value?—My diagram gives the comparison which the Committee make themselves, but I think that all comparisons should be made with guns under precisely the same circumstances.

4345. Do you consider that any comparison for accuracy of fire, unless the number of shots fired is the same, is a comparison of any value?—If several shots are fired it gives you a fair indication.

4346. If the number of shots are unequal do you think the comparison is of any value?—Yes; I think the mean numbers of the shots should be the same if there are a considerable number.

4347. What do you call a considerable number of shots, do you think nine a fair test?—I think not.

4348. How many times was your gun fired?—This second diagram shows the results of 11 rounds, at 5° of elevation.

4349. But how many times was your gun fired?—This was the only competitive trial in which the gun was fired.

4350. How many times was your gun fired in that first trial?—Nine times for the first diagram of accuracy at 2° elevation; that was the whole time that it endured in the competitive trial; it had fired 300 rounds previously; that diagram is my first comparison, the second is the 11 rounds, at 5°, fired long before, but which are also given in the Report.

4351. Captain *Jervis.*] What was the number of rounds fired with Mr. Bashley Britten's gun?—I have taken the Committee's own diagrams in each case, and I find that it is 15 rounds, because his gun went through the whole number of competitive rounds; the shunt diagrams are one of six rounds, the other nine rounds, and mine at the same elevation of 5°, is 11 rounds.

4352. *Chairman.*] Can you give the Committee any information with reference to what the shunt gun has done since; do you know of any experiments with that gun subsequently?—Yes; one 300-pounder shunt rifled gun has been fired nine rounds at Shoeburyness, and the muzzle is nearly off, but the exact number of rounds could be easily found by the return.

4353. What is your authority for that statement?—I was informed so by those who were aware of the number of rounds that were fired, but the return would at once show it.

4354. Is the 600-pounder also a shunt gun?—Yes.

4355. Can you tell us anything about that; has that gun been tried?—I think not; it is about the same weight as the Horsfall gun.

4356. Do I understand you to say that you merely know these things by report, and that you have not any proof of the shunt gun not being successful?—I have seen the muzzle myself; the outer tube is cracked round, and the inner tube is nearly gone. The reason I looked at that was to observe, as a naval officer, whether Sir William Armstrong's new system of shunt rifling would answer or not, for I was fully convinced that the principle was wrong, and that it would produce that effect.

4357. But

4357. But still if you had only seen the one gun, that might be an accident, might it not?—Of the cast-iron guns that were rifled on the shunt principle, and strengthened, there were a great number that went.

4358. Captain *Jervis.*] Was that from their being cast-iron guns rifled on the shunt plan?—They were on the shunt plan.

4359. Do you think that they would not have gone if they had been on any other plan?—I will not say that; I believe it was in part from faulty form.

4360. Has any satisfactory plan yet been pointed out for rifling cast-iron guns?—No other mode of rifling has been tried with the strengthened cast-iron guns.

4361. What have they been doing for the last three years?—I really do not know; I am aware that Captain Blakeley's strengthened gun was tried at the proof, but not in continuous firing with service charges; the other guns which burst, burst after a succession of increasingly heavy charges, at the proof butt.

4362. Mr. *Laird.*] In one of the 300-pounders at Shoeburyness, did not the breech give way?—That was a smooth-bored gun; it gave way in proof, and the breech blew out. I saw that myself.

4363. *Chairman.*] Do you know whether there are any naval officers employed on the trial of those shunt guns?—The present Admiral Superintendent at Malta, Admiral Austen, lately wanted to see the shunt gun loaded, just before going out there; he mentioned who he was, and he was turned away.

4364. But is there any naval officer concerned with those experiments on the shunt gun?—Only the officer on the Select Committee, I think.

4365. Captain *Jervis.*] Who is that officer?—Sir William Wiseman.

4366. Was not Sir William Wiseman for many years the commander of the "Excellent"?—For some years.

4367. Is he considered in the navy a judge or not in those matters?—I think not, by those who have themselves studied the subject of rifled Ordnance.

4368. Was he appointed in order to follow up the experiments of the Committee on the part of the navy?—He was appointed by the Admiralty.

4369. Will you look to Captain Caffin's evidence, at page 123 of the Report of this Committee last year; at question 2468, he was asked, "Have you anything to say with respect to the decision as to what guns should be introduced into the naval service?" Now, at the time he was asked that question, he was at the War Office, carrying on duty as Director of Stores, and also as Director General of Naval Artillery. His reply is, "That mainly rests with the Admiralty; they invariably ask my opinion, but the official decision is entirely with the Admiralty." Then he was asked, at Question 2469: "But the matter of advice rests with you a good deal, does it not?" and he replied: "To a certain extent: the Ordnance Select Committee report, and I make any observations upon questions arising, and pass them to the Admiralty." Now, you have already Sir William Wiseman as a naval officer on the Ordnance Select Committee, and you have Captain Caffin, of the Navy (also an officer of experience), to carry on the details between the War Office and the Admiralty; and we have it in evidence that Captain Hewlett, of the "Excellent," has for the last six years been carrying on experiments for the Admiralty, making his reports to the Admiralty, and the Admiralty furnishing him with the reports of every naval officer afloat who has an Armstrong gun on board: may you not, therefore, say that you have a permanent standing naval committee of Sir William Wiseman and Captain Heath?—Capt. Heath has only just come in Sir W. Wiseman's place; he is a man of considerable talent, and I believe his being on the Committee will be found valuable for the public service.

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4370. You have a naval officer on the Select Committee, you have a naval officer at the War Office, you have a naval officer who has been carrying on experiments for six years, and yet you say you do not consider that naval officers were consulted for the introduction of this gun into the Navy?—It is quite true that there is one naval officer on the Ordnance Select Committee; but how many Artillery officers and other officers are there upon it?

4371. Will you explain the difference between a naval gun and a land gun?—Certainly. A naval gun is a gun which is moving, and not upon a fixed platform; it is continually changing its position.

4372. In what way is it continually changing its position?—In every respect. A gun may be a very capital target-gun, which the Armstrong guns are; but these guns are not fit for naval guns; and I think if the Navy as a body were questioned, they would say the same.

4373. We have heard from Captain Hewlett that he has received reports from the Navy, and the results he arrives at are exactly contrary to your own opinion?—It is difficult to determine; Captain Hewlett told me that he would be very glad to have more reports. The only time that I am aware of when this gun was tried as it would be on service was on board the "Trusty," and then it failed signally.

4374. But Captain Hewlett has fired 7,000 or 8,000 rounds on board the "Excellent," and he is satisfied with the gun?—Target practice is different from practice at sea: directly officers have practice at sea, great numbers are dissatisfied with the gun; at least they tell me so.

4375. You were asked, at Question 4115, "Will you, if you please, state whether you consider that the large sum of money which has been expended on Armstrong guns has been judiciously expended?" to which you answer, "Certainly not." Now you admit that there was a necessity for a rifled gun on board men-of-war?—Yes.

4376. You also admit that you were not aware of any better gun being in existence at the time this gun was introduced?—I do not think I made such an admission; I think that is a mistake; for I have elsewhere stated my belief that the Armstrong rifling was derived from the Prussian, which, in my opinion, is a better plan, and expels its shot with less strain upon the gun.

4377. We have it in evidence that Captain Caffin, representing the Admiralty, was in consultation with the Admiralty during that period, and that they were reponsible for that gun. Are the Committee to understand that the Admiralty have, in your opinion, made an injudicious selection?—People, when they see a thing first, may be very much taken with it; its accuracy and long range please people at first; it is a pretty gun to look at, but it is unfit for the rough wear-and-tear of the service. I think it is not

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fair to ask me to pronounce an opinion on Captain Caffin; for he had other duties to perform, which were quite enough to occupy any man's time, and which did occupy the whole of his time, so that he could not be present at Shoeburyness and see the experiments.

4378. Was he not Vice-President of the Committee up to 1858?—That is long before the gun was adopted as a naval arm.

4379. When was the boat-gun first introduced on Captain Hewlett's report?—You really can hardly argue from a small gun up to a large gun.

4380. Do you object to the 40-pounder as a naval gun?—Yes, certainly.

4381. Do you object to the 70-pounder as a naval gun?—Yes, certainly.

4382. Do you object to the experiments carried on with the 100-pounder previous to its introduction, or are you acquainted with the circular to the Navy from the Admiralty, dated the 30th of October 1851, referring to the 110-pounder, and stating what experiments had been made with it previous to its introduction?—I am quite aware of that circular.

4383. Was not that circular issued to the Navy n order to reassure them about the gun, and to satisfy them that it had been properly experimented upon before it was introduced?—It was an Admiralty circular issued to give the men more confidence in its strength. Had I been employed at that time, I should have done my utmost to make the gun successful; but, thinking that it would fail in warfare, I have steadily, as you are aware, spoken against the gun, and pointed out its defects, not quietly and in corners, but, as you know, in the presence of Sir William Armstrong's partner, who was allowed to answer at my lecture.

4384. But, at all events, the Admiralty appear to have fully entered into the question, and to have issued a circular stating the grounds on which they had acted; is not that so?—The circular contains an account of the fact of the gun being fired very slowly, and standing an immense weight of projectile with a service of powder. But, as you know, the shot fired on that occasion was not fired under the same conditions as a shot fired in actual service; the lead on the projectile was pared down, and it was not squeezed through the bore in the same rapid and straining manner.

4385. I was not aware of that myself?—I may say that I have not the slightest feeling against Sir William Armstrong; he behaved in a very kind and gentlemanly way to me, and it is rather unpleasant to have to speak of these things.

4386. You state in your evidence that you have all along asked for "a strong gun." "A strong gun!" But that is what everybody has been asking for, is it not?—I said that because I thought your previous questions implied that I had been very much in favour of weak guns.

4387. Are you acquainted with any stronger gun than the gun which at present exists in the service?—The gun has been very much matured by the ablest mechanic in the world, without exception.

4388. Who is that?—Mr. Anderson.

4389. Will you be kind enough to state how Mr. Anderson has strengthened the gun?—By continual little improvements.

4390. I do not say that he has not done so; but still I should like you to state what the improvements are?—I will take the 40-pounder: the forged breech-piece has been lengthened by him and brought under the trunnions; and that, I consider, is a very great improvement. As to the question of the strength of a gun, that, of course, has two phases. The Armstrong gun is a strong gun to resist direct internal pressure, but it does not endure; the wrought-iron expands, and the gun stretches and becomes unserviceable.

4391. *Chairman.*] What proof have you of that?—Seeing a large number of the inner tubes which have been partially ejected from the bore through the expansion of the outer casing of the gun.

4392. Upon what number of guns have you formed that deduction, and what number of tubes have you found in the state which you describe?—All the departments in the Arsenal are conducted so admirably, that there is no objection to your seeing them. The only objection that can be raised is, of course, the objection against your knowing the Armstrong construction, which was for a long time a secret. Now, I have had considerable kindness shown to me, in that respect, from every one in the Arsenal. I inquired into these things, not at all with a view of bringing them forward invidiously, but with a view, I hope, of benefiting the service generally. I have therefore been enabled to see a great many of those failures, and I know of a very large number besides.

4393. Are they failures after the guns were finished for the service, or failures in the course of the manufacture?—Both.

4394. Mr. *Beecroft.*] Do you attribute those failures to the inner tubes being made of coiled iron?—I attribute them to the construction of the gun, which I consider faulty.

4395. And do you attribute them to the inner tubes being made of coils?—That would increase the liability of the gun to fail.

4396. Has it been proved that the guns have failed in consequence of the inner tubes being made of coiled iron, and so proving defective?—The practical test of that is, that they are now beginning to make the internal part of steel. If they had been satisfactory when made of coiled iron, they would not, of course, have begun to make them of steel.

4397. Speaking from your experience, would you prefer the inner tube being made of coiled iron, or of a mild steel, or homogeneous iron?—Of a mild steel, certainly.

4398. How long have you been of that opinion?—For a very considerable period. But I have pointed out that the guns should be made, as far as possible, of one piece from the muzzle to the breech. A hostile shot would hit the muzzle, and therefore it is better to have one thick piece there than a number of small pieces.

4399. *Chairman.*] Allow me to ask you again, upon what number of guns you have formed that induction, and what number of tubes you have found in the state described?—I think I have seen about a dozen guns with the inner tubes seamed and unserviceable.

4400. Out of what number of guns?—I suppose there may have been about 600 100-pounder guns made; but I speak from memory. I have not been taking notes; of course, I have not gone as a spy. With regard to the remainder of your question, with reference to the tubes, I should say I have seen from 200 to 300 bored out.

4401. They

4401. They also being 100-pounders?—Yes, 100-pounders (the guns now called 110-pounders.)

4402. And you think you have seen as many as 200 or 300 bored out?—I should say so; quite that number.

4403. Were the guns of which you are now speaking guns that had been delivered for service, or were they guns of which the inner tubes had been taken out in the process of manufacture?—The guns were completed, and given, as I inferred, to the Store Department, and afterwards bored out, some slight defect being found in the coils.

4404. *Colonel Dunne.*] Do you know that of you own knowledge?—I do.

4405. *Chairman.*] Those guns had been delivered to the Storekeeper, and then returned to the Gun Factory for the purpose of having defects remedied; is that what you state?—I suppose so, because the guns had been completed.

4406. Then where have the guns been tried? how did the storekeeper find out the defect?—I think the largest number of the instances probably were from Sir William Armstrong imagining that the solid tubing did not answer so well as the coiled tubing.

4407. You think that the guns were bored out, not on account of any defect being found upon trial, but on account of Sir William Armstrong having changed his opinion with respect to the way in which those guns ought to be made?—Sir William Armstrong stated that such was the case in a letter to the Times, and said, that his plan was to have the interior of his guns of coiled-tubes, those bored out were forgings. Whether there were defects in these tubes, or whether there were not, I did not follow them closely enough to observe; but I suppose there was some good reason why such a large number were bored out.

4408. Mr. *Beecroft.*] These were solid forgings?—These were solid forgings. But, with regard to the other guns, I saw several that came from the service with the inner tubes seamed. I saw, also, that brass tubing was tried in an 110-pounder and in a 40-pounder, but that, of course, did not succeed, because the brass stretched.

4409. Mr. *Baring.*] Who is it that will give us accurate information upon the point of the substitution of those tubes. — Mr. Anderson, of the Royal Gun Factory.

4410. Have you been speaking to the Committee from actual knowledge, or only from what you have picked up in the Royal Gun Factory?—No, not from what I have picked up; from actually seeing.

4411. But still you are not responsible yourself for the manufacture of the guns, or for the alterations in the manufacture?—Certainly not.

4412. And, probably, are not aware yourself of the reasons for the alterations made?—I have already stated that I can only suppose that the reason is the one that Sir William Armstrong stated in his letter to "The Times," namely, that some guns were made with interior tubes from solid forgings, which was not his plan.

4413. Probably Sir William Armstrong would be better able to tell the Committee what his reasons were than anybody else?—I should think so.

4414. Sir *Morton Peto.*] You say there were 200 or 300 of those guns that were bored out?—Yes.

4415. Mr. *Laird.*] Were those guns at Woolwich?—Yes.

4416. Then Mr. Anderson will be the best person to give us information about them, I suppose?—Yes.

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4417. The guns were guns that were being altered under his charge?—Yes.

4418. *Chairman.*] Did you see those Shorncliffe guns?—Yes.

4419. How many of those guns did you consider to be badly injured?—The three guns which I saw were all badly injured.

4420. Sir *Frederic Smith.*] Do you mean unserviceable?—Yes.

4421. Could not they have been easily repaired?—No, certainly not; one of them was split through the breech, another was pulled open, and in the third the inner tube was protruding, which could only be repaired by boring out and re-tubing.

4422. *Chairman.*] I rather think the vent-pieces of those guns were the old pattern, were they not?—That I do not know, but that would not make any alteration with respect to the endurance of the guns.

4423. It has been asserted in evidence before this Committee that the vent-pieces which are now in use to a certain extent for the 12-pounder and 40-pounder guns are perfectly successful; are you able to give the Committee any information with respect to those new vent-pieces?—They may be perfectly successful, but one sees that the wedge breech-loading plan is now being brought forward for extensive trial, which I should take as a proof that they are not successful.

4424. That is in the larger natures of guns, is it not?—No, in the 40-pounders.

4425. Can you say whether, generally speaking, in the Navy muzzle-loaders or breech-loaders are preferred?—I am satisfied that muzzle-loaders are preferred, and I believe if you were to question the Admiralty they would say the same thing.

4426. Sir *Frederic Smith.*] Is it not a great advantage to be able to load from the breech, so that your ports are never exposed?—In firing on the recoil principle you can load very quickly from the muzzle. I used to be loader in the "Excellent," and I think any man can load very quickly with a muzzle-loader if he is thoroughly up to his work. The sense of security when standing near the muzzle-loading gun would more than counterbalance anything gained from loading at the breech.

4427. The body may be safe, but not the arms; is not that so?—That depends on your own care in sponging; I have sponged a great deal myself, and I never was in any doubt with respect to the safety of my arms.

4428. But if the centre of the gun is lying in the centre of the port the arms must be exposed?—Yes; and in the same way, if you are breech-loading with the wedge out, the shot are liable to strike the wedge, and that may cause a great many splinters.

4429. But the ports are now much smaller than they used to be, and, of course, the gun to some degree closes the port against the hostile shot?—Yes, but that is a very trifling advantage; the man would not think about his arms, or hesitate on that ground in the heat of action.

4430. Colonel *Dunne.*] With respect to the guns which you have referred to as faulty, had any of them been served out, or were they in the process of manufacture?—There were about thirteen

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thirteen, of which I had seen the inner tubes seamed.

4431. But had they been served out, or were they merely guns that had been experimented upon?—They had passed proof and had been issued for service. I am aware there is a distinction made which would perhaps cause them not to appear in the returns, because the greater part are, I believe, marked down as "experimental guns." If the guns go to Shoeburyness, they are considered as experimental guns; so that, unless you had a return of all the guns actually fired, those of which I now speak might not be included.

4432. Can you tell the Committee what proportion of those guns were supposed to have been given out in a perfect state fit for service, and what proportion were merely given out for experiments?—I imagine that the greater part of the guns are called experimental which go down to Shoeburyness; but of course I have not watched the guns with the intention of checking anything of that kind.

4433. But you can distinctly state that the guns, of which you have been speaking, are supposed to have been in their perfect state?—They were in their perfect state, each gun.

4434. Sir *Morton Peto.*] Were those 13 guns 100-pounders?—Yes, 100-pounders; but I do not at all refer to them invidiously. I will go to the 40-pounders as well, if it is desired.

4435. And the 200 guns that you saw re-bored were also 100-pounders, were they?—Yes.

4436. *Chairman.*] Can you give the Committee any information with regard to the trials that were made of those large service guns before they were introduced into the naval service?—I imagine that they were introduced without trial from the fact, that before any gun was obtained at all, certainly before any gun was ready for trial, there were a very large number of 100-pounder shell delivered at the Arsenal from the Elswick Ordnance Company. These shell are there now, about 20,000 *l.* worth.

4437. Captain *Jervis.*] Does not the Admiralty Circular say distinctly what had been done in that respect?—It speaks of the trial at endurance proof.

4438. Will you kindly read it?—"Endurance under testing of a 100-pounder Armstrong breech-loading gun." My Lords Commissioners of the Admiralty desire that the following particulars, as to the testing for endurance of an Armstrong 100-pounder breech-loading gun, be communicated for the information of the officers and crews of Her Majesty's ships. The proof of this gun, which was conducted in the usual manner, was commenced on the 20th June last, and was carried on until 100 rounds had been completed on the 10th September last." I beg to call the attention of the Committee to the dates and the time that elapsed in the firing of those 100 rounds, so that by no possibility could the gun get warm. "The charge of powder used, was the service charge of the gun for shot of 100 lbs., as originally proposed by Sir William Armstrong, viz., 14 lbs., which will not be exceeded for shot of 110 lbs. For the first 10 rounds, cylinders of 100 lbs. were employed; for the next 10, cylinders of 200 lbs., and so on up to the last 10, for which cylinders of no less than 1,000 lb. were employed. These last were eight feet eight inches long, and projected two feet beyond the muzzle." May I remark (I hope it is not considered invidious to do so, for having said that the guns are faulty in principle, I am bound to show that they are so,) that the lead was turned down off the cylinder, therefore it did not close the bore of the gun, and it was not driven through with that high velocity with which the service shot is driven, which prevented the destructive effect from the wedging of the shot through the gun at starting, when fired on service; and therefore it had not the same effect upon the gun. "The gun was found to be uninjured. The powder-chamber and shot-chamber were found slightly seamed in the direction of the grain of the iron. The breech-screw worked freely throughout the experiment. It is hollowed on the face, but hardly perceptibly. Two steel vent-pieces were broken in the course of this experiment, viz., at the 28th and 31st round respectively; one wrought-iron vent-piece, after being used from the 32d to the 81st round, was found so much worn on the face as to injure the cups, and a second wrought-iron vent-piece was used from the 82d to the 100th round. This vent-piece was observed at the 91st round to exhibit a number of fine cracks, which extended considerably in the course of the remaining nine rounds; it broke at the fourth round of a subsequent experiment with proof charges of 27½ lb., and a single proof shot 110 lb." It does not say whether that was in the same gun, and I am not aware whether it was or not; but I believe it was in another gun. "The breech copper required refacing at the 30th round; after the 35th round it was removed and replaced. At the 58th round the new copper was refaced, and replaced after the 63d round; the copper then put in received no repairs during the rest of the experiments. Lubricating wads of the service pattern were used for the first 10 rounds, afterwards those of Captain Lyon's pattern. The powder-chamber was washed out after each round to allow the expansion of the breech copper to be measured," which, I may be permitted to observe, kept the gun perfectly clean. "Cups of strong tinned plate were used for the first 35 rounds, but were too weak to resist the pressure exerted by the gas with cylinders of the weight then in use, and were replaced by copper cups, which answered well for the remainder of the trial, being seldom broken. The recoil, as the experiments advanced, became very violent; the suspending rods ultimately were removed, and the gun was placed on a species of carriage which recoiled up a steep inclined plane, checked by sand. It is stated, however, by the Inspector of Artillery, that great difficulty was found in completing the experiment even with this arrangement. The gun used in these experiments was of Elswick manufacture, made entirely on the coil principle, and weighed 81 cwt. 3 qrs. 16 lb., and was of the usual external dimensions. The remarkable strength exhibited by this gun is very satisfactory, and would appear to leave nothing in that respect to be desired, except some improvement in the vent-pieces, which every endeavour is being made to effect."

4439. *Chairman.*] Was not that a tolerably severe test that was applied to that gun?—Krupp's gun, rifled as an Armstrong (it is only by comparison that we can judge) received the same test, and the bore was unseamed and without a flaw; and there is a gun made by an English company, of which you can also get a return, Messrs. Naylor Vickers's gun, in which the

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the steel was even cut into the shape of the exterior of an Armstrong gun, which must be very trying to the metal, and it also went through a similar test.

4440. Captain *Jervis.*] What was the date of the experiments with Mr. Naylor Vickers's gun?—They have been just completed; 100 endurance proof rounds were fired, but they have fired 30 proof rounds since, I think, with double charges, which is an infinitely greater strain.

4441. *Chairman.*] Is that gun in any way injured?—I understand that Mr. Naylor Vickers's gun is perfectly uninjured.

4442. Have you seen the gun since it was fired?—Yes, I have seen the gun since it was fired.

4443. And do you consider it to be without injury?—I have not examined it sufficiently closely to say; for, of course, I do not want to check every trifling thing.

4444. Mr. *Beecroft.*] Were not both those guns made from solid masses of cast-steel?—Yes, both of them.

4445. And therefore they were quite different in principle from Sir William Armstrong's gun?—Yes, and much better.

4446. Marquis of *Hartington.*] What sized gun was Mr. Naylor Vickers's?—A 40-pounder, I think.

4447. And Krupp's guns?—One of them was a 100-pounder.

4448. Mr. *Dodson.*] Do you know what the cost of Mr. Naylor Vickers's gun is?—The cost of making any gun must at first be very great; I think 80*l.* a-ton is what was stated.

4449. *Chairman.*] Is that 80*l.* for the manufacture of the gun, or 80*l.* for the material of which the gun is made?—I think it was delivered at 80*l.* for material only. Of course, that price is only for one gun.

4450. Mr. *Beecroft.*] Are not Krupp's guns made from one solid ingot of steel?—They are cast and then hammered; and the hammering gives them that remarkable closeness and tenacity. They have this great advantage over a coiled gun, that whereas the coiled gun is continually stretching, and must of necessity become injured, the steel gun may go on for hundreds and thousands of rounds and be perfectly uninjured; the hardness of its internal part is, of course, a great advantage for firing rifled shot.

4451. Mr. *Baring.* If a steel gun fails, what is the effect?—It would break to pieces.

4452. It would burst?—Yes; it would burst just as a cast-iron gun would burst.

4453. And the pieces would fly?—Yes.

4454. What is the effect upon the Armstrong gun when it fails?—It rends; but the breech of his 300-pounder would have knocked the side of a vessel out.

4455. You mean the smooth-bored gun?—Yes, the smooth-bored gun.

4456. Are you aware that that gun was damaged in proof?—It had been fired with 90 lbs. of powder, which gave it just about the same strain as if the gun had been rifled and fired with the charge it was intended to bear.

4457. But are you aware that it was damaged in the proof?—Yes; I saw the damage.

4458. Captain *Jervis.*] You say that Krupp's gun is made out of steel, cast and hammered; have you seen the process?—I have been shown it by Krupp's people in the Exhibition.

4459. Are you aware that Krupp would allow nobody to see that process?—I am aware he would not let anyone in to see the mixture of the metal; but that is another thing.

4460. There is a good deal in mixing the metal?—Certainly.

4461. Are you aware that Krupp's guns were tried as far back as 1851, when a beautiful 9-pounder was experimented upon?—Yes, I am aware of that; but there is also a cylinder in the Arsenal which I understand has stood a very remarkable proof.

4462. Are you aware that those guns failed utterly at that time?—I saw the diagrams of the experiment, and read an account of it. I consider that the experiment was tried in a way which was very likely to make it fail.

4463. Mr. Whitworth has paid more attention to making guns of cast steel than anybody else in England, and two years ago he wrote to the War Office to say that he gave up making large guns of homogeneous iron, because steel was not to be obtained of the requisite size?—Where there is a demand there will always be the supply. The Armstrong guns being in the field, the other manufacturers would not come forward. One Company which were casting guns for us, Messrs. Walker, said to me, "Sir William Armstrong has got possession of the field, and we shall give up making cast-iron guns."

4464. But had the article proved itself worthy of a demand?—It was early shown that the inner tubes were very faulty.

4465. Are you aware that the very first gun of Sir William Armstrong's ever tried, was made with cast-steel?—Yes; and I cannot conceive why he gave it up, unless it was that there was a previous patent.

4466. But if you refer to Mr. Anderson's evidence of last year, you will find that he told the Committee that even at that time he did not know where to find steel of proper quality?—Krupp's steel was never tried in the interior of the gun.

4467. But it had been tried as a gun previously, had it not?—I am not aware of any early trial except that trial which you have mentioned with the proof charges, which would have been a tremendous strain upon any gun.

4468. I am not stating that we shall not some day get to steel, but merely asking you with regard to the 100-pounders, being made of wrought iron in 1861, whether there did not then seem to be an impossibility of getting blocks of steel that you could rely upon?—I believe that in that day, if they had sought blocks they might have been obtained; and if any encouragement had been given to a large manufacturer like Krupp, I believe he would have produced them without the least difficulty. The "proof" of the Armstrong gun expands the weapon, and the coils stretch at the breech, from the shot wedging the gun open; and unless a manufacturer was aware of the fact, that the gun was expanded thus, he might not make his iron sufficiently elastic. Krupp being now aware of that, has made his gun sufficiently elastic to stand proof charges, when rifled on the Armstrong system.

4469. Mr. *Beecroft.*] Did I understand you to say, that about two years ago Mr. Whitworth abandoned the idea of using steel for his guns?—Certainly not; I never said anything of the kind. There was a difficulty in procuring Mr. Bessemer's metal at that time. Mr. Bessemer said to me, "I cannot afford to put up a furnace and make a large gun for trial at my own expense;

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pense; and even if I succeeded, I do not know, as Sir William Armstrong is in possession of the field, that my metal would be adopted."

4470. It is now found that the mild steel can be made much better than it was three or four years ago, and of a quality suitable for the guns?—Yes.

4471. And in consequence of that Mr. Whitworth recommends homogeneous metal or mild steel in preference to coils for manufacturing guns?—Yes.

4472. Because he has now found steel of a quality which two years ago was not to be found?—There was not a demand for it, and, therefore, it was not made.

4473. *Chairman.*] Is there any other information that you wish to give to the Committee?—A table was laid before you respecting the strain upon the gun in the various systems of rifling, and I only allude to it because I wish to show clearly that there were other systems of rifling affording excellent hopes of success which have not been fully tried. I refer to a former statement put in by Mr. Anderson, with regard to the trials of cast-iron cylinders, rifled on various systems.

4474. Perhaps you will put in a statement of your views upon that subject, which may be introduced into the Appendix?—I will do so.

4475. Is there any other point to which you wish to refer?—There is one which I believe to be very important, it having been referred to, I think, by Sir William Armstrong, and I should like to touch upon the point. Sir William Armstrong stated here (it is a question of mere common sense), that only soft metal upon shot can succeed, and he went on to say that, from his having soft metal on his shot, his was a much better plan than Mr. Whitworth's.

4476. In other words he said that the mechanically fitting shot will not answer?—That the mechanically fitting shot will not answer; but there are one or two very important points in that evidence. In the first place, in giving evidence, Sir William Armstrong said that along his own projectiles he had observed a marking, showing that his shot was never perfectly steady in the bore.

4477. That his shot vibrated?—Yes; which is perfectly true of his projectiles in the shunt-gun. He then said: Mr. Whitworth's shot did the same; that it went backward and forward in the bore. Now, the fact is, that Sir William Armstrong's shot does vibrate, and Mr. Whitworth's is tight against the driving-side and cannot vibrate at all. The proof is very simple, and it materially affects the question at present before the committee. Mr. Whitworth's shot, on being driven onward by the powder, is always pressed against the incline, which stops it from going out until it unwinds itself from the spiral, on reaching the muzzle. There is nothing in the system of rifling the gun to make the shot vibrate; it is pressed close against the bearing side with enormous force, and were the gun not to be lubricated there would be a considerable amount of adhesion, but the lubrication prevents adhesion, and the shot glides easily out of the gun.

4478. Mr. *Baring.*] Do you consider that statement of yours proof sufficient that the shot does not vibrate?—Yes, certainly; it goes out of the gun without the least noise, which proves its perfect stability of rotation.

4479. You think that those two arguments are sufficient to prove that the shot does not bound?—I think that the mechanical law of its pressing against the bearing side is sufficient; the shot is pressing onward, and would turn the gun if it were not much heavier than the shot. You may just as well say that if a cogwheel were driven by an engine and was turning machinery, that the cogwheel would press against it, and then jump back from its work.

4480. Captain *Jervis.*] But what does it do when it sticks in the gun, and bursts in the gun?—Mr. Whitworth has tapered away the shot at both extremities, and the effect of that tapering is, that the centre only of the shot is resting in the bottom of the bore, and the powder in the upper part makes use of the extremity of the shot as a lever; the powder presses more on the upper than the under part; and hence tends to work the shot backwards and forwards in the gun, and cause an indentation at the seat of the shot. In order to try guns under perfectly equal conditions their shot should equally have flat ends. The shunt shot, however, does vibrate, and for this reason, that there is no principle of centring in the grooving, and unless you centre it on first starting (which you can only do by grooves with rounded bearing forming a shoulder), it must necessarily go along the bottom of the bore. The shunt shot does go along the bottom of the bore till it comes to where there is a rise in the groove (it is a double groove), and that rise in the groove at once throws the shot right up against the upper side of the bore of the gun. And the effect upon that 300-pounder at Shoeburyness distinctly bears out what I have now said; it must damage the gun. There is another disadvantage in the shunt rifling, besides not centring the shot at first, which is, that the groove being flat, the first impulse of the powder upon the shot, causes it to strike at nearly right angles against the flat bearing surface, which must jar the gun. The only way to get rid of that, is by rounded bearings, upon which the shot will at starting centre round easily. Another point which has been mentioned, is with regard to the friction in the bore. It was stated here that the friction of soft metal was considerably less than the friction of hard metal, and that it was so, especially at the point where abrasion takes place. But one thing was entirely disregarded, which was the cohesion. Wherever you have soft metal, such as for instance, a white metal, you obtain a certain amount of cohesion; with the first shot there may not be much, but the groove becomes pewtered, and so with the next shot there is a great deal more cohesion of bearing surfaces, and the next shot perhaps still more. This cohesion retards the shot, and therefore brings a greater strain upon the gun. The true plan with a rifled gun is to lubricate it well, and then you may advantageously have a hard iron bearing, but you should also centre the shot on starting. With a rounded bearing and a shot well lubricated, you will get everything that is attempted to be secured in the shunt gun, without its disadvantages.

4481. Can you give us any facts to prove the correctness of the theory which you have been enunciating, with regard to the fact that the hard substance does not produce an injurious effect upon the muzzle of the gun?—Perhaps you will let me read from this Report, which shows that three hundred rounds have been fired with my own gun, firing iron shot the whole time. The Report at page 46, states, "The bore of the gun

gun is apparently uninjured." When I looked at the grooving of this cast-iron gun with the assistant superintendent at Shoeburyness, who examined it most carefully, he said that the grooving was perfect; that gun was fired with 5½ lb. and 6 lb. charges of powder. Now, if we turn to the lead-coated shot which, according to the theory placed before you, most easily abraid, and therefore should have a less wearing effect than iron upon the rifling, we find according to the official statement contained in the Ordnance Select Committee's Report just quoted, at page 32, that after 202 rounds (I speak now of Mr. Bashley Britten's gun, and I do not speak it at all invidiously), "the driving edges of the grooves showed slight marks of abrasion." I may say with regard to this report of the Ordnance Select Committee, as it has been quoted, that the guns were put into what was called a competition list; and at page 6, it is stated that "Each competitor was informed that he was at liberty to apply to the projectiles now to be tried, every improvement suggested by his previous experience, provided he should not by so doing introduce any substantial novelty of principle or construction." I think this shows that that was to be the competition; I never heard of a competition before this ultimate trial. At the time that my gun was put into this competition with projectiles made in this improved way, viz. longer and thinner, so as to hold a larger powder charge, it had fired 300 rounds, but no other gun had fired anything like that number at that time; I have only found a statement (though there may be more), of Mr. Bashley Britten's gun having fired 202 rounds, but every other gun had fired a very small number, so that the competition in which I was ostensibly at liberty to try every improvement suggested by experience, ended in my gun only firing nine rounds, and failing at the 310th round. But I certainly object altogether to the Report of the Committee, and am satisfied that looking at it fairly, any one else would come to the same conclusion; and I am sure I could convince any one who would go quietly into the matter, that there are several erroneous statements in it. They sent me a correction of the figures for the rectangle of other guns, but in the deflexion column for the 2d August, they put yards instead of feet in showing the amount of comparative error for my gun, and have not corrected their mistake.

4482. Were all those different guns made in the same place and by the same manufacturer? —They were guns given at different times, and they were never brought under equal conditions. I objected to the Committee that they were tried under different conditions.

4483. Do you think that guns can be fairly tried unless they are manufactured by the same person, or, at all events, unless care is taken, so far as the mere manufacture goes, that one shall be as good as the other?—I think that if a trial takes place without that being done, the money is all thrown away.

4484. Captain *Jervis.*] Were not these all cast-iron service 22-pounders?—Yes.

4485. Identical in weight, size, length of bore, and everything, except that each competitor had his own system of rifling? — They were not identical in number of rounds fired, and they were not identical in respect to the finish of the shot.

4486. Do you mean that each competitor had a shot of his own?—Yes, most of them were made in the Arsenal; mine were not planed on their bearing surfaces with a rifling bar, like those of others firing iron shot; in fact, I was told without hesitation, by a gentleman connected with the matter, that if I did not send in my shot at once, the Committee would at once decide in favour of lead-coated shot.

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4487. *Chairman.*] But if the guns were all service guns, and if the shot were all made in the Arsenal, surely the guns were tried as fairly as possible, were they not?—No; because my gun was never made to compete, it was merely made for the purpose of testing whether my system of rifling could be adapted to cast-iron guns, or rather it was granted to me for that purpose, and not rifled to be tested in a competition.

4488. Captain *Jervis.*] They gave you a second gun, did they not? — The Admiralty asked for one, and it was given in precisely the same way.

4489. Was it not your own plan of rifling?—Yes; but a plan of rifling may be carried out with insufficient precision.

4490. Colonel *Dunne.*] Did you tell them that before they rifled the gun that was sent them afterwards; did you give them directions to change the rifling?—None whatever.

4491. Then how would they be justified in changing the rifling?—It was never talked of as a competition until long after the gun had been rifled.

4492. You state that you were told that the Committee were going to decide against you; was that told you on any authority whatever?—I said unless my shot were sent in in time.

4493. Was that told you by anyone who was authorised by the Committee to make any communication?—No; but such was the case. It is not that, however, that I insist upon; it is that I sent in, before the trial took place, to state that unless a gun were rifled for competion, and I was put upon the same footing as the other competitors by having a new gun, I should not be satisfied.

4494. How could they know your latest improvements?—I told them.

4495. Did you direct them to rifle the gun in that manner?—I had nothing to do with the rifling.

4496. Sir *Frederic Smith.*] Was not the gun rifled on instructions furnished by you?—My first plan of rifling was sent in, and there was no modification made whatever.

4497. Captain *Jervis.*] That first plan was your own system of rifling?—Yes.

4498. The second gun was rifled in the same manner?—Yes.

4499. If every inventor changed his plan of rifling from time to time, do you think the experiments could possibly go on?—There was no inconvenience about it; if a system is worth trying at all, it is worth trying under the best conditions.

4500. Do you know how many competitors there were, eight or ten?—No; there were Mr. Lancaster, Mr. Bashley Britten, Mr. Jeffrey, Mr. Haddan, and myself.

4501. Was not Mr. Lynall Thomas one of the competitors?—No, he was not in the competition.

4502. Colonel *Dunne.*] Would the Committee have been justified in altering the rifling of your gun when you had not given them instructions? —I have never changed my rifling, or the bearing surface at all; mine is a plan of rounded

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grooving, totally distinct from any nipping plan of Sir W. Armstrong's. I merely spoke of a modification with respect to the degree of twist given to the rifling.

4503. Did the Committee then follow out that rifling, as laid down by you in the second gun?—Yes.

4504. It was rifled like the first gun?—Yes.

4505. What authority had they to alter the rifling?—None whatever; what I complain of is that they never told me it was to be a competitive gun.

4506. Mr. *Laird.*] Did you ask the Committee to rifle the second gun in a different manner from the first?—No, I made no objection; I was very glad to get a gun at all.

4507. You did not ask for an increased twist, did you, till long after the trial had taken place?—Yes, long before the trial took place.

4508. But not before the second gun was made, did you?—The second gun was, I understood, to be used for the purpose of trying whether cast-iron guns could be rifled.

4509. But did you ask for an increased twist before the second gun was commenced?—No.

4510. Captain *Jervis.*] It was after it was made and rifled according to your plan, that they told you they were going to compete?—Not until after the 300 rounds were fired.

4511. Mr. *Laird.*] You asked them to give you a gun for that competition?—Yes, and to embody the latest improvements: to have a gun for that purpose would have been a very trifling expense, and it could soon have been done.

4512. Mr. *Baring.*] As far as I understand you, you complain that you did not have an opportunity afforded you of trying your system of rifling, quite apart from the question of cast-iron guns?—I complain that the report is incorrect.

4513. You complain that your position as last but one among the competitors is not a fair position: is that so?—I complain of what they say, and also when they class my system with Sir William Armstrong's, as having a soft bearing upon the shot.

4514. The first point which this Committee was to inquire into, was whether cast-iron guns could be rifled with safety?—Yes.

4515. I find in the report that they say, "These systems of rifling may be compared under the following heads: First, safety and durability of the gun, which includes absence of liability in the projectile to jam in the bore;" and then the Committee rank them in the following order: Britten, least liable; then Jeffrey; Thomas; the shunt-gun; the French gun; Haddan; then your own; and lastly, Lancaster. Do you complain of the order in which those names are placed in that report?—I think there was no evidence whatever to say that my gun was so liable to rub down, because after 300 rounds it was not so; there was no appearance of it.

4516. You consider that the report, putting you last but one, was not a fair report?—Certainly.

4517. And besides that, you think you ought to have had an opportunity given you of trying your system of rifling?—Certainly.

4518. With a view of its adoption into the service, instead of the polygroove system of Sir William Armstrong?—Certainly.

4519. I understand you to say that you complain of the authorities not giving you an opportunity of trying that system?—That would not be quite a correct way of putting it, I think; because the War Department have lately granted me a gun, which they are making in the arsenal with a steel bore, a gun of 7½ tons. I do not complain of that point, but I complain of the report of the Committee as being unfair towards my system. I have advocated firing with round ball; Sir William Armstrong's system was not to fire with a round ball, but latterly he has been narrowing his groove till he has been able to fire with a round ball. The Select Committee brought those two systems together, and put mine with Sir William Armstrong's, as if they were the same system (one being a compression system, and the other that of spherical shot); and they now tell me that as my system is something like Sir William Armstrong's, that they doubt whether they can go on with experiments with it. The real fact being (by the Committee's own showing, at page 14) come to what I had advocated at the earliest time. I take the least quantity of metal out of the gun by my groove, but you will see in the diagram, opposite page 46, that they have caricatured my rifling.

4520. In fact, you contest entirely the conclusions to which the Committee have come?—Yes; and on this ground, that from their not showing the systems of rifling as separate, the authorities may say that Captain Scott's groove is nearly what Sir William Armstrong's is; whereas it is on a totally different principle. If you will observe, they have classed me with him, at page 9, art. 2.

4521. There are eight competitors, of which Commander Scott comes No. 7; one of them being the shunt gun, which comes No. 4?—Yes; that was the shunt gun with its projectiles which were touched up in the most careful way possible at Shoeburyness during the firing.

4522. That is to say, you being one of the competitors, and being put No. 7 in the list, you consider the committee did not treat you with that fairness which you ought to have received; you think that you ought to have stood higher up in the list?—I will state the facts: my gun had no sooner burst, after their refusing to give me a gun for this trial, (the other competitors having had several guns,) though I had been paying my own expenses: I say my gun had no sooner burst, after the 310th round, than Sir William Wiseman found time to write off that very night to say, that my gun had burst from the shot having jammed in the bore, that being contrary to the fact, and wholly incorrect, and hence the position given to my gun.

4523. General *Peel.*] Whom did he write to?—A Lord of the Admiralty. The next morning I went to London, thinking I should be in time, when he said he was very sorry indeed to find that my gun had burst by the jamming of the shot; and I was told by a friend, afterwards an Admiral in Commission, that the Admiralty had previously thought very highly of my gun, and were sorry that it had burst by the jamming of the shot; and this was the result of my four years' constant anxiety, trouble, and expense.

4524. Do you think that you would now be able to introduce a system of rifled cast-iron guns under which you conceive they might be advantageously rifled for the service?—I have already stated, that though it might be a question in 1859, it is not a question now, and that we ought not to go back to that material when we can get a better.

4525. Then,

4525. Then, in fact, you do not think that your system of rifling can be adopted with advantage for cast-iron guns; you are not of opinion now that the adoption of your system for the existing 32-pounder cast-iron gun would be advantageous?—I do not think it would be advisable to try them with any system of rifling.

4526. Then practically, in the report of this Committee, there has been no injustice done to you, because it appears that no system whatever could be successfully adopted for rifling cast-iron guns?—This book will go before the world, and people will read it who do not know the facts, and will accept the conclusions. I think that it has done me very considerable injustice.

4527. Captain *Jervis.*] Am I right in gathering from a passage in your previous evidence, that you consider, as a naval officer, that a high degree of velocity is desirable at close quarters?—Yes, a high degree of velocity.

4528. The greatest velocity you can get?—Yes, the greatest velocity you can get.

4529. Are you aware of any authority on naval gunnery that takes a different view of that subject?—Certainly not.

4530. You are not aware that Sir Howard Douglas is rather strong the other way?—Speaking of wooden ships?

4531. Speaking of iron ships?—Sir Howard Douglas opposed iron ships altogether.

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Captain CHARLES J. F. EWART, R. N., called in; and Examined.

4532. *Chairman.*] WHAT position do you occupy?—I am the captain of the "Cambridge."

4533. How long have you been in that position?—About 2½ months.

4534. And before that what position did you occupy?—I was captain of the "Melpomene."

4535. Where was she?—She was four years in commission in the Mediterranean, and the North American and the West Indian stations.

4536. How many Armstrong guns had you on board the "Melpomene"?—The latter part of the commission we had 13 guns.

4537. Did much practice go on during the time that you had those 13 Armstrong guns?—The practice allowed by the instructions was quarterly practice, and averaged, probably, about six or eight rounds a gun.

4538. Sir *Frederic Smith.*] Each quarter?—Yes, if I remember rightly; I was permitted some additional practice in consequence of the guns being newly supplied to me.

4539. What was the calibre of those guns?—We had five 110-pounders and eight 40-pounders.

4540. *Chairman.*] How many guns altogether had you when you commanded the "Melpomene," and what was their size?—Our armament was reduced from 51 to 35 when the Armstrong guns were supplied.

4541. Therefore, you had about one-third of Armstrong guns?—Thirteen in 35.

4542. You mean 35 guns in all?—Yes, 35 guns in all.

4543. What opinion did you form of the Armstrong gun from your experience of it?—With regard to its accuracy, I practised with it in close harbours at 2,600 yards with very great success; the shot, on almost every occasion, would have struck a large boat.

4544. Did you practise with the guns out of harbour?—I also practised with the guns out of harbour at long ranges, but I cannot say with any success, inasmuch as the ship rolled exceedingly; and in consequence of the ship rolling, it was impossible to make any accurate firing.

4545. Was the firing not so accurate when the ship was rolling as the firing with the 68-pounder smooth-bored guns?—We practised at much greater ranges.

4546. But, with regard to accuracy, how did you find the firing?—The smooth-bored gun is a sufficiently accurate gun, within certain limits, I should say, such as 1,000 yards.

4547. But out at sea, when the ship is rolling, taking 2,000 yards or 3,000 yards, which would you consider to be the most accurate gun?—I would sooner have the Armstrong gun.

4548. Major *O'Reilly.*] Do I understand you to say that up to 1,000 yards, at sea when the ship is rolling, the smooth-bored gun is more accurate than the Armstrong gun?—It would be hardly fair to say that; the fact is, we had so few shots that I never knew the Armstrong gun fired at 1,000 yards. I have practised always at long ranges. In all the practice I think the splitting of one vent-piece was the only fault that we had.

4549. What would you consider to be the defect of the gun; take, for instance, the slowness of firing?—With regard to slowness of firing, I think the Armstrong gun would not be of much use where quick firing was required. I should prefer having a smooth-bore gun for anything that would require quick firing, which would be necessarily the case at short ranges.

4550. But would not the slowness of the gun going off after the trigger is pulled, very much affect the accuracy of the gun when the ship was rolling at sea?—That would be prevented by the practice of the men; they would get into the way of making the same allowance for that that they do for the other gun. We have to make a similar allowance for wind. When they came to know the fact that the Armstrong gun takes a little longer in the shot passing along the barrel, they would make an allowance for that.

4551. You do not attach much weight to that objection?—I do not attach much weight to that, because practice would enable the seamen to get over it.

4552. With regard to the ammunition, have you any remarks to make, with regard to the fuses, for instance?—I look upon the whole matter as in a state of infancy, both as regards the system of the lever, and with regard to the ammunition. I should think that the lubricating wad, in the manner in which it is at present secured, would, in any close action, cause a great deal of trouble from the way in which it is screwed on.

4553. Does the powder which is used make a very thick smoke?—The smoke is very much thicker, and I endeavoured to ascertain if it would be a serious inconvenience in action on a covered deck, but as we had only four guns I do not think it would be a matter of any serious moment. Of course, if the whole battery was composed of Armstrong guns, the smoke would be a very serious inconvenience.

4554. In a ship, such as the "Melpomene, with

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with 35 guns, how many Armstrong guns should there be in the ship, do you think?—One in five is as many as a ship ought to have, I think, to be of any service in close action.

4555. You would desire to use them as chase guns chiefly?—One in five would be an ample number.

4556. Have you had many experiments tried under you with Armstrong guns since you became captain of the "Cambridge"?— None whatever beyond the usual practice.

4557. You have no remarks to make to the Committee with regard to what occurred on board the "Cambridge"?—None whatever.

4558. Had you any means of forming an opinion with regard to the American guns when you were on the coast of North America?—I had no such means. The delicacy of my position, as a captain of a man-of-war, prevented my personally examining the guns that I saw. Going over Fortress Monroe, I saw a great many; they were principally Columbiad's, Parrott's, and two of very large size (in a sand-battery), called Rodman's; one was 28 tons (I was told by the chief of the staff), and the other was 25 tons.

4559. Do you know whether those guns were mechanically fitting guns, or whether they were guns with projectiles made of soft metal?—I saw the projectiles, and I think they were coated with soft metal. The sentry who had charge of them, mistook me for a Federal officer when I came up, and I had just time to look at them.

4560. Do you know whether any Whitworth guns were in Fortress Monroe?—I should say not.

4561. Nor Captain Blakely's?—Neither, I think.

4562. Sir *Frederic Smith.*] Does not the wind have more effect in deflecting an elongated shot than a spherical one?—Yes, very greatly.

4563. Then you have made more allowance?—Yes, I think so.

4564. You state that these Armstrong guns are of little value comparatively in close action?—I think so.

4565. Will you state why you think so?—I think in close action, even in the very best drilled ship, there would be accidents with them.

4566. Arising from what circumstance?—It might occur in the lever part, if not screwed well home, in which case the vent-piece would be blown out. The tin-cup with which they are at present fitted, would also, perhaps, cause great inconvenience; and I think it would be a good thing if some substitute could be made for it; for when I have put the cup in, I have found, in screwing the vent-piece home, that it had fallen; and you are obliged to stop and put it up again, which, in action, would tend to create accidents.

4567. At night-quarters, accidents would be more frequent, I presume?—That would necessarily be more dangerous still; because the personal supervision of the officer would be wanting.

4568. In fact, simplicity is of great importance in action, I suppose?—Unquestionably. In fact, I should not care to have any guns of that nature for close firing.

4569. What proportion of Armstrong guns would you prefer if you were to regulate the armament of your ship?—One in five, at the outside.

4570. Mr. *Laird.*] You consider that the Armstrong guns are too complicated for general work on board ship in action?—Yes; but it is the best thing I have seen, at present, for chase guns. I am not acquainted with Mr. Whitworth's gun.

4571. Colonel *Dunne.*] In regard to the objection which you make to the Armstrong gun, namely, its inaccuracy from the rolling of the ship, is that peculiar to the Armstrong gun, or does it apply to every other gun?—It necessarily occurs; but then the Armstrong gun is only supplied for long ranges, at which you could not use the other guns at all.

4572. But any other gun would be equally liable to that objection?—Yes.

4573. You think that all future actions will be carried on within certain moderate distances?—My opinion is that they will be.

4574. And that at those distances a muzzle-loading gun is most likely to be effective?—Yes; that is my opinion.

4575. You think that the 68-pounder 95 cwt. gun is likely to be most effective?—Those are the best guns going. I would rather have them than anything else.

4576. On iron-plates, at the distances at which you contemplate that naval actions, are, for the future, likely to take place, would they be effective?—Yes, certainly, at the distances that I contemplate. I think that a fast ship will always do her best to get alongside a slower one, and that the action will have to be fought with guns that will fire the greatest number of shots.

4577. And, therefore, there would be no advantage in these complicated and more accurate guns?—Except for chase-guns and for bombarding at long distances.

4578. Major *O'Reilly.*] Does not the chief cause of the liability to accidents in the Armstrong gun, in close action, arise from the whole construction of the breech?—Yes; from being a breech-loader; but I should also say that a rifled gun which is not a breech-loader is equally liable to accidents by the shot jamming on its way, which would lead to the gun being withdrawn from action, and not used at all.

4579. Mr. *Beecroft.*] Are the Committee to understand that you would prefer, in close action, the smooth-bored gun to any rifled-gun?—Yes, I think so.

4580. Mr. *Baring.*] Your objection is not confined to the breech-loader, but to the rifling system?—Rather to the rifling. I should like a few rifled guns for chace, and bombarding at long distance, but not for close action.

4581. Is that in consequence of not being able to fire a shot so broad in diameter with a rifled-gun as with a smooth-bored gun?—I prefer the smooth-bore, on account of its simplicity in one respect; and then you can throw a greater diameter of metal, and I am not sure that it has not a more smashing effect.

4582. Is it not possible to make a muzzle-loading rifled gun just as simple as a breech-loader?—I think not; because if the shot does jam, there is an end of the gun.

4583. Even a muzzle-loader would still be a more complicated gun than the smooth-bored gun?—Yes; I think that in close action I should sooner have the smooth-bored gun.

4584. You were in the Crimea, I believe?—Yes.

4585. What ship were you in?—The "Trafalgar."

4586. And you were engaged, and also heard what

what those ships did that went into the Russian batteries?—They did nothing at all; at least it was a mere trifle. They were at a distance of 1,500 or 1,000 yards.

4587. At too great a distance to do anything?—Yes; they were of no use at all at that distance, and I do not think that a rifled gun could have done a bit better.

4588. In reference to shelling a place at a long distance, I presume that the Armstrong gun would have a great advantage?—Yes; I think that for shelling a place it would have a very great advantage, but at that distance of 1,000 yards you can throw a shell equally well from a 95 cwt. 8-inch gun.

4589. Marquis of *Hartington.*] I think I understood you to say that you only knew of one accident to occur during your practice with the Armstrong gun?—Yes; merely a vent piece split, that was all; it was discovered after being taken out.

4590. There was no want of confidence among the seamen, I presume?—Just at first there was, because in a ship close to mine a vent-piece had been blown out, owing, no doubt, to the lever not having been properly screwed up, and after I had had the men well drilled into it, they used the gun just the same as any other.

4591. And with as much confidence?—Yes, perfectly; but in close action, when men get excited and their blood is up, they might make mistakes.

4592. But you never observed any apprehension among the men of any accidents happening?—Not the slightest.

4593. *Chairman.*] You say that a muzzle-loader rifled gun must always be liable to the shot jamming. Do you know whether the breech-loading guns are liable to that inconvenience?—No; I cannot say.

4594. Sir *Frederic Smith.*] Should you think it a very perilous operation to run past a battery with an iron-clad steamer, supposing the battery to be armed with Armstrong guns, and the range to be 1,000 yards?—I should wish to know the thickness of the iron.

4595. Supposing that it was 4½ or 5 inches thick?—Of course I should not in the least hesitate about doing it, but I think the ship would be hit pretty hard, because guns have a very great advantage on shore upon an immovable platform over a moveable ship.

4596. *Chairman.*] In going in at a distance of 1,000 yards at 15, or 16, or 12 knots an hour, do you think there would be any risk of the ship being pierced or disabled?—I am not acquainted with the experiments in iron-clad ships; I have been abroad for the last three or four years.

4597. Sir *Frederic Smith.*] Take a wooden vessel?—As a matter of course the ship would be perforated by as many of the guns as they could fire, and as a matter of course I should put her through it.

4598. You would not hesitate to make the attempt?—Certainly not.

4599. Mr. *Baring.*] Have you contemplated the effect of the explosion of a shell on iron-plated ships supposing the shell was made to penetrate the iron-plate?—If it were 4½ or 5 inch iron backed with wood, with iron inside again, the shell exploding between the two, I think it would have a very serious effect upon the ship by destroying the wood.

4600. Mr. *Beecroft.*] Would it set the wood on fire?—Yes, I should say it would. I saw a hot shot take four hours to put out, that had got into the timber just between the two casings. If it got into the timber below the orifice you would have considerable trouble.

4601. If it got between the two iron plates it would endanger the ship, I suppose?—Yes; they would have considerable difficulty in getting at the place to remedy the mischief; you would have to remove the interior plate before you could get at it.

4602. Mr. *Baring.*] We have had no experience of any serious naval warfare since the perfection of the shell, have we?—Not since the Sebastopol business.

4603. There the effect was by no means satisfactory, I think?—I have known a shell burst a great hole large enough to drive a carriage through in some of the old ships.

Jovis, 18° *die Junii*, 1863.

MEMBERS PRESENT:

Mr. Baring.	Mr. Laird.
Mr. Beecroft.	Mr. Monsell.
Colonel Dunne.	General Peel.
Captain Jervis.	Sir Frederic Smith.

THE RIGHT HON. WILLIAM MONSELL IN THE CHAIR.

Captain ALEXANDER THEOPHILUS BLAKELY; called in, and Examined.

Capt. *A. T. Blakely.* 18 June 1863.

4604. *Chairman.*] You were an officer of the Royal Artillery?—I was; 21 years ago I entered Her Majesty's Service, and left it a couple of years ago. During all that time I have given a great deal of attention to the question of gunnery.

4605. You left the Royal Artillery, I think, to prosecute your studies in gunnery?—Yes.

4606. I need hardly ask you whether you are well acquainted with the progress of artillery in this country?—I have given a great deal of attention to the progress of artillery in this country, and abroad also.

4607. Are you satisfied with the system of ordnance which was adopted by the Government in 1858; and do you think the expenditure which has since been incurred thereon has led to satisfactory results? — I think the breech-loading system of rifling is not very good, and I think that fact might have been discovered with very much less expenditure than has taken place. The coil system still remains, and it has still very many advocates; but I really think that the expenditure of a very small sum of money (certainly under 50,000*l.*) would have proved that there are other materials better adapted for guns than coiled wrought-iron. For guns of moderate size I rather think that cast-steel would have been found the best; but the great objection I have to coiled wrought-iron is that there are very great difficulties in making extremely large guns of sufficient power to render our coasts secure from foreign iron-clad ships. In consequence of this, as I think, misdirected expenditure, we have at this moment no rifled gun for general use in the Navy; we have no gun in the service sufficiently powerful to destroy an iron-clad ship with comparative certainty. I understand that there is only one 600-pounder made, and that is only for experimental purposes.

4608. That 600-pounder is made on the same construction as the 300-pounder, I think?—I believe so; it is made at Elswick, from drawings supplied by Sir William Armstrong.

4609. The 300-pounder has not been a successful gun, I think?—One gun, which was called a 300-pounder, but which, in fact, only threw a 150-lb. shot, burst—blew its breech out; another gun of the same size has since been tried, and I understand that it has been successful. But I think the worst consequence of the course which our experiments have taken has been the delusion produced that 4½ inches of iron are shot-proof. The result of this strange hallucination seems to have been that we have spent millions in the construction of a navy which is fit only to compete with English ordnance, but which would be totally defenceless against the more powerful guns produced in foreign countries.

4610. Do I understand you to say that there are other guns in use in foreign countries, which at 1,000 yards would pierce the "Warrior"?—In August 1861, at Gâvres, in France, a 6⅝-inch gun, with 27 lbs. of powder, threw a 99-lb. bolt through a target, representing the "Warrior," at 1,093 yards; that was a rifled gun.

4611. Captain *Jervis.*] Where was the plate made?—It was made by Petin and Gaudet, the same makers whose iron has since been tried at Portsmouth, and which was very highly reported upon there.

4612. *Chairman.*] Have the French, in consequence of the light thrown on their operations by that experiment, thought it right to construct their iron-clad vessels more strongly than ours?—I apprehend that they have, in consequence of that experiment, discontinued the building of them.

4613. Do you mean to represent to the Committee that there has been no iron-clad ship since that time made in France?—My impression is that, in consequence of that experiment, they stopped making any beyond those which had already been laid down; but I have no accurate knowledge upon the subject.

4614. Captain *Jervis.*] Have not some iron-clad ships been laid down since that time at L'Orient?—No, I believe not, though I am very ignorant on that subject.

4615. *Chairman.*] What is your authority for your statement with regard to what the French are now doing in regard to iron-clad ships?—I am not at liberty to give you my authority.

4616. Will you kindly proceed with your statement?—My objection to the system of rifling adopted in this country is, that it does not admit of firing round-shot from the same gun. There is nothing more easy than to rifle a gun in such a manner that it may with equal facility fire round-shot and rifle-shot, and that is a very great advantage with a naval gun; because, in case of the water being sufficiently smooth to justify long-range firing, the gun can then be used as a long-range rifled gun, and on the enemy approaching it can be used with round-shot. I am perfectly aware that the rifled shot, at close range, is equally efficacious as the round-shot. The contrary opinion is very much held; but calculations and experience

experience must convince anyone that the blow given depends almost entirely on the charge of powder used. The advantage of round-shot for close firing is the great rapidity with which it can be loaded and handled.

4617. Mr. *Beecroft.*] In smooth-bored guns do you mean?—In any gun; it is as easy to load round-shot into rifled as into smooth-bored guns; it is rather easier, in fact.

4618. Colonel *Dunne.*] I understand you to say that spherical shot is easier loaded than long shot?—Yes, more quickly; it is lighter, being generally half the weight.

4619. *Chairman.*] Do you take exception, *ab initio*, to the proceedings of the Government in introducing the Armstrong gun into the Service; or do you merely object to the very large expenditure which, subsequently to its first introduction, has been made upon it?—I object to the very large expenditure which was incurred before the experiments had been sufficiently developed; I think there were too large a number of guns ordered of untried size.

4620. In the first instance there were only 180 guns ordered?—Yes; the field systems had been tried, and had to a considerable extent succeeded.

4621. Up to that point you make no objection?—I think that the competition preparatory to the introduction of the Armstrong gun into the Service ought to have been a little more generally known. For instance, I was not aware myself, till last year, that there was a Committee sitting on Rifled Ordnance, when I saw it in this blue-book.

4622. General *Peel.*] Have you ever submitted a gun to that Committee?—Not a rifled gun; I would have done so if I had known there was such a Committee.

4623. *Chairman.*] Not before 1859 you mean?—Not a rifled gun.

4624. Then you have submitted a gun on the coiled system?—I have submitted a gun on the coil system; that was a well-known method of making guns.

4625. But that gun was not a rifled gun?—No, not a rifled gun; my great object was the production of very powerful guns for the naval service, not for the field service.

4626. Captain *Jervis.*] If you had brought to the notice of the War Office a field-gun, you would have been called upon to compete, I suppose?—I should think so, certainly. I may say that I consider that the coil system was at that time a mere makeshift. The object of the coil system is to get welds of wrought-iron round the gun in that form in which they will be least mischievous. But it must be evident that if we can get rid of the weld altogether, we gain an advantage. Now, ever since 1859, the greatest number of guns that I have made have been made with cast-steel where we have no weld.

4627. *Chairman.*] Is your system of coiling the same, or does it resemble that of Sir William Armstrong?—I cannot see any difference. The manager of the Butterley Company in Derbyshire, which made my guns in 1855, who accompanied me to the Woolwich Arsenal last year or the year before last, said, in my presence, that the system on which they were making the guns there was identically the system on which they had made guns for me in 1855.

4628. Have you ever had any communication with Sir William Armstrong on that subject?—Yes. I had taken out a patent on the 27th February 1855; and Sir William Armstrong made his experiments with his first field-gun, or his second field-gun, with my permission. There was no doubt about the identity of the thing. I gave him permission to make those experiments; and on the condition that I allowed him to continue those experiments, he promised to negotiate with me before using the gun commercially. I will read his own letter: "21st January 1857. My dear Sir,—Your letter of the 19th has reached me here. At present I am making no guns, except for experimental purposes. If you have a valid patent for any method of construction which I may adopt, I shall of course, on being satisfied of that, negotiate with you before I use it commercially; until then the question may fairly stand over. You will observe that I make no claim to exclusive invention of anything in my letter to 'The Times,' but have confined myself to a simple description of what I have done. I am, dear Sir, yours truly, (signed) W. G. Armstrong.—Captain Blakely."

4629. That is a hypothetical statement of Sir William Armstrong's altogether, is it not?—I give you the words of his letter.

4630. He says, "If you have a valid patent for any method of construction"?—I have got the words of my patent here, and we are all pretty well acquainted with the construction of the Armstrong gun.

4631. In fact, have any proceedings taken place since then with reference to that letter?—When Sir William Armstrong's gun was introduced into the Service, I wrote to him to remind him of his promise, and his reply was this: "Newcastle-on-Tyne, 9th April 1859." (It will be apparent from this date that he had had plenty of time). "Dear Sir,—I have received your note of yesterday, and assure you I have no intention of doing you any injustice. At the same time, I must inform you that the guns which are being made under my direction have no interior lining of steel, and are not in any way affected by your patent." Sir William Armstrong had then introduced a modification, which I suppose he conceived to be a great improvement; namely, making the entire gun of wrought-iron, instead of the method, which he had first used, of a steel barrel covered with wrought-iron coils, which is clearly within the words of my patent. My specification says: "The improvements relate, first, to a method of forming guns with an internal tube or cylinder of cast-iron or steel, enclosed in a case of wrought-iron or steel. I sometimes form the outer surface of the inner tube somewhat conical, the greatest diameter being just in the front of the trunnions, and tapering both ways, and apply the outer casing in the form of collars or rings driven thereon; and in some cases, I apply two or more layers of such rings, according to the strength sought to be obtained, the trunnions being of one piece with one of the rings. The outer casing may, however, be applied in the form of collars or rings heated and shrunk upon the cylinder or tube; but I do not claim as my invention the method of forming guns or cannon by the application of collars or rings heated and shrunk upon a cylindrical inner tube, save and except when the internal diameters of such collars or rings are, previously to being heated, so much smaller than the external diameter of the inner tube on which they are shrunk, that, after being cooled, the outer casing formed by the rings or collars is

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in a state of tension or permanent strain, similar to that produced when the rings or collars are forced upon a conical surface, as before described." "In place of forming the outer casing of separate collars or rings, I sometimes form such outer casing of wire or rod, wound spirally, in one or more layers, around the inner cylinder or tube."

4632. Captain *Jervis.*] Do you remember in what year you were quartered at Landguard Fort?—I was quartered there in 1850-51.

4633. Were you not there about 1854?—I was not quartered there.

4634. But you were down there, were you not?—I do not recollect; but it is very probable that I was.

4635. Were you not there, at the time that Sir William Armstrong was delivering his fuse gun, in 1853 or 1854?—No.

4636. Are you sure of that?—I am certain; I never had the pleasure of meeting Sir William Armstrong till 1856.

4637. You do not recollect, early in 1855 or at the end of 1854, Sir William Armstrong meeting you at Landguard, and describing the whole of his proposed system?—I never had the pleasure of meeting Sir William Armstrong till 1856.

4638. *Chairman.*] Will you kindly point out, on those diagrams in the room, what the difference is between your system of construction and Sir William Armstrong's system? — There is no difference whatever, except that I dislike the coiled-iron tube; I prefer to use steel.

4639. But is there any difference with regard to the external part?—There would be no difference; I could not tell one of Sir William Armstrong's guns from one of my own.

4640. But I understand you to say that you consider the inner tube should be made of steel?—I think that the whole of a moderately-sized gun should be made of steel; and for guns of very large size, for which we cannot yet get the steel, I think cast-iron or brass is more applicable than coiled-iron.

4641. But at the time when you took out your patent, you proposed to make use of coils?—For the outside only.

4642. Therefore, at that time, your idea would be that the external portion of the gun should be made of coils, and the inner tube of steel?—Yes, exactly so; and that is what Sir William Armstrong's gun is now.

4643. Captain *Jervis.*] You are aware of the principle of Mr. Treadwell's patent of 1854, I suppose?—Yes.

4644. Is it not very similar to your own?—They have no relation whatever to each other, no resemblance. Mr. Treadwell's invention, which was very valuable, related only to the method of forming each individual coil, as it were, and the welding of the coils into a tube.

4645. Was it with a view of strengthening the gun by the coils being put one over the other?—No; but I will give you a copy of his book. The real essence of Sir William Armstrong's gun and of my gun does not lie in the use of those coils, but in the manner in which the outer coils are made to compress the inner ones, so as to make the two layers act in unison in resisting the strain. This is very clearly explained by Sir William Armstrong in his letter, of 14th July 1855, in the blue-book of last year.

4646. Has not this question, with regard to priority of claim, been submitted by you to the Attorney General already?—No, never.

4647. Did you not appear before him in opposition to Sir William Armstrong's patent, and did not he dismiss your application?—That would have no reference to the case in point.

4648. I merely ask whether you did not apply in that manner on this point to the Attorney General?—No, not on this point; I have frequently submitted this point to the War Office, and the reply was a denial of the similarity of our plans.

4649. *Chairman.*] Could you put in any of those letters from the War Office?—Yes. But with regard to the essence of Sir William Armstrong's system, it is this: he says, in the letter to wich I have referred, "It is to be observed, in reference to the strength of steel or wrought-iron cannon, that the resistance of a cylinder to internal pressure does not increase in the ratio of its thickness. If the cylinder be regarded as made up of a number of concentric layers, each capable of sustaining, without injury, a degree of extension proportionate to its length, it is obvious that the greater the circumference of each layer, the less will it be stretched by a given distension of the bore, and, consequently, the less will it contribute to the general strength of the cylinder. The ratio of this decrease is very rapid, being as the square of the circumference or distance from the centre inversely; and consequently, when the cylinder is thick, the deficiency of strength from this cause becomes very great." For instance, in a gun of that size (12 tons), where the inner circumference of such tube would be 21 inches, the circumference of the outer tube would be 81 inches in round numbers, and the disproportion of the strength exerted by them would be inversely as the square of the circumferences, or 1 to 16; that is to say, according to Sir William Armstrong's own showing, if that gun was built up (as was proposed, I think, by Mr. Tredwell) merely of muffs of coiled iron welded together end to end, then the outside, not compressing the inside, would only exert one-sixteenth as much strength as it could do when applied in the way which Sir William Armstrong proceeds to describe. He says: "Now this defect can only be remedied by giving to the external portion of the cylinder a certain initial tension, gradually decreasing, and finally passing into compression towards the centre; and although this condition cannot be effected by any known process of forging or casting, yet where wrought-iron or steel is the material used, it may in a great measure be attained by shrinking an outer cylinder upon an inner one, and in like manner superadding others, until the requisite thickness has been acquired." The increase of strength by the substitution of a coiled cylinder for a cylinder made in any other way would be as 3 to 2 at most; the increase of strength which is obtained by building it up of concentric laminæ, each calculated to exert its whole force in resisting the internal pressure, is as, at least, 5 to 1. Sir William Armstrong, I am aware, has since expressed a different opinion. On one occasion, at the Institution of Civil Engineers, in 1860, he said: "My gun is composed wholly of wrought-iron, and the prominent feature in its manufacture is the application of the material in the form of long bars." I was astonished at this, having spoken to Sir William Armstrong before about it, and knowing he had once understood the theory, I asked if he really meant this. He replied, "The outer layers and rings

rings of metal are not put on with any calculated degree of tension; they are simply applied with a sufficient difference of diameter to secure effective sprinkage." On another occasion, Sir William Armstrong was even more definite in his statement. He says, in an address to the Institution of Mechanical Engineers in 1861, he being the president of the Institution for that year: "There is a limit to the thickness of bar, which it is convenient to bend into a spiral; and in making a gun on this system, the required diameter is made by applying successive layers of coils, each layer being shrunk upon the one beneath." Here he gives you to understand that it is for convenience that he has two layers instead of one, quite forgetting that on the former occasion he gives a calculation by which it is shown that the increase of strength obtained by putting the outer layer of that gun into a state of tension is as 16 to 1, and that it is not for mere convenience.

4650. *Chairman.*] The last day on which Sir William Armstrong was examined here he was asked by one of the honourable Members of the Committee: "You mentioned on the last day of your examination that one of the results which had been obtained by the country had been a system of construction of guns; will you kindly say whether you mean by that the system of strengthening the guns by hoops of wrought-iron, or whether you include the system of constructing the barrel?" He replied, "I referred to the coil system." Then he was asked, "You referred both to the barrel and the external hoops?" and he replied, "It is applicable to the barrel and to the hoops." He was then asked, "Then what do you mean by the coil system as applicable to the barrels and the hoops?" to which he answered, "The gun with the barrel of steel, as exemplified in my first gun." He was asked, "What is the system of construction which you say the country has gained?" He says, "The coil system; but I have made the internal tubes of the gun of both steel and coils; I use the coil as an alternative when steel is not to be obtained." "Then how do you define the system of construction which you referred to?" "The construction of the gun by a coiled tube, and it may be either applied to the barrel or not. I have already stated that the system which I most approve of is to use steel for the barrel, provided I can get the proper metal; but if it cannot be got, then the alternative is to use coils for the barrel." Supposing Sir William Armstrong to obtain steel that he can use for the barrel, what is the difference between his system and the system you have been describing?—If Sir William Armstrong makes the gun with a steel barrel enclosed in a casing of coils, he makes precisely that gun which I had the honour of offering to the British Government in 1855.

4651. Minus the rifling?—Minus the rifling.

4652. Captain *Jervis.*] The object in 1855 was to obtain a rifled gun, was it not?—My object was to obtain a very powerful gun.

4653. But was not the object of the Government in 1855 to obtain a rifled gun?—I do not know; I rather think not; in fact, I am sure it was not.

4654. You are surely aware of the great desire of the Government to obtain a rifled gun at that time?—I am aware of the reverse, and I will give you chapter and verse for it. At page 163 of last year's Report of this Committee, you will find a Report of the Ordnance Select Committee, dated 29th November 1855; the subject under discussion was this very letter from Sir William Armstrong of the 14th July 1855, which I have quoted. The Ordnance Select Committee, acknowledging that Sir William Armstrong's little rifled gun (which they had tried) had several merits, say: "The range appears to be very great, almost equal to the 68-pounder gun, as might have been expected from a superior rifle or wall-piece of this description." The Committee of 1855, being composed of Major-General Cator, Captain Caffin, Colonel Tulloh, Lieut.-Colonel Askwith, Lieutenant-Colonel Eardley Wilmot, Captain Younghusband, Captain Boxer, Captain Young, Mr. Gregory, Professor Sylvester the great mathematician, Mr. Abel the chemist, Mr. J. Anderson, Colonel Pickering, and Captain Campbell, were not at all astonished at the great range of this rifled gun. They naturally said, "We know a rifled gun shoots better than a pistol, and of course a large rifled gun will shoot better than a smooth-bored gun."

4655. I do not speak of the Committee's anxiety to obtain a rifled gun, but of that of the Government?—That I had no means of knowing.

4656. Was not this gun brought to the notice of the Government in 1854 by the Duke of Newcastle?—His Grace authorised Mr. Armstrong to make an experimental rifled canon; but the first experiments were not with built-up tubes.

4657. *Chairman.*] Will you be good enough to proceed with the extract from that Report of the Ordnance Select Committee?—Yes; they say: "The principle of building is somewhat similar to that proposed by Captain Blakely (and now under trial with a 9-pounder gun), only carried out in a more mechanical way. While admitting that this arrangement is superior to many others which have been suggested, the Committee are not so far satisfied of the advantages of any built gun as to induce them to recommend the extended adoption of this principle." Surely this system cannot have become a valid subject to patent in 1858, it being clear that I had forestalled Sir William Armstrong in using it in 1855.

4658. Captain *Jervis.*] Strengthening cast-iron with wrought-iron?—That was not the system; the invention had no relation to the metal used, but to the manner in which it was to be put together.

4659. Mr. *Laird.*] Your patent was for a coiled gun with a steel interior tube, was it?—I was aware that a steel casing would be better than coils, and I included that in my patent. I say, "enclosed in a casing of wrought-iron or steel." I was perfectly aware that steel would be better if we could could get it. Sir William Armstrong and I both wished for steel, but not being able to obtain the steel, I thought (my object being to get a very powerful gun) it would be better to use cast-iron or brass for the main portion of the gun.

4660. *Chairman.*] Would you make the inner tube of brass?—Yes; I have also made some guns with an inner tube of wrought-iron.

4661. And brass?—Yes; I have made some. This very last year I was making a 900-pounder, and it required very great care to get a gun of that immense size to stand; and although bronze gun-metal is extremely expensive, I thought it safer to line the breech with bronze.

4662. In answer to some questions of an honourable and gallant Member, you stated that there has been a controversy between you and the

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the War Department upon the subject of your invention, and that that controversy has been carried on in writing; could you put in that correspondence?—I have it in a very incomplete form.

4663. No doubt it could be supplied by the War Department?—I should think that the War Office have it all. I am afraid the correspondence will show that I thought myself very illused, and that I got rather out of temper.

4664. General *Peel.*] In what year was that correspondence?—It commenced in 1859.

4665. *Chairman.*] Will you state, in the first instance, whether you ever disputed the validity of Sir William Armstrong's patent?—I commenced an action against the Elswick Ordnance Company.

4666. Will you kindly give an account of the proceedings which you took?—I commenced an action against the Elswick Ordnance Company for infringement of patent; and as the Government was at the same time making the same guns at the Woolwich Arsenal, I also gave the Government notice that I had a patent for the invention.

4667. What was the date of the commencement of those proceedings?—April 1859.

4668. Have those proceedings terminated?—The War Office wrote to me to state, that I must make my option either of proceeding against the Elswick Ordnance Company, or else of discontinuing my correspondence with them on the subject. They declined to correspond with me about the alleged infringement at Woolwich, unless I desisted from my action against the Elswick Ordnance Company; they said it would have been inconvenient (which it would manifestly have been) to carry on a parallel correspondence.

4669. In what manner did you give up the action against the Elswick Ordnance Company?—I received a letter from Mr. Clode.

4670. Will you read that letter?—It is dated the 3d of May 1859; it was addressed to Messrs. Cunliffe and Beaumont, my solicitors: "Gentlemen,—Your letter of the 29th ultimo, written on behalf of Captain Blakely, addressed to the Elswick Iron Company, has been forwarded to this Department; and I am desired by Secretary Major General Peel to apprise you that this Company is working out, under the officers of this Department, a patent belonging to Her Majesty's Principal Secretary of State for the War Department, in respect of which no complete specification has yet been enrolled. I am directed to observe that Captain Blakely now is, and for some time past has been, in communication with the Secretary of State, in respect of an alleged infringement of his patent rights; and, perhaps, you will obtain from him his election, either to continue those communications in the same spirit in which he has opened them, or to act through you as his legal agents: for it is scarcely necessary to observe, that the Secretary of State cannot communicate with both Captain Blakely and his solicitors.—I have the honour to remain, your most obedient servant, *Charles M. Clode*, Solicitor to the War Department." Mr. Montague Smith told me that an action would not hold against Her Majesty's Ministers; that the guns were being made for the Queen, and a subject would have no remedy.

4671. Captain *Jervis.*] Therefore the patent does not belong to Sir William Armstrong, but to the Government?—It is the property of the Government.

4672. Will you look to Question 2364 of last year's evidence before this Committee: the Solicitor to the War Department says that the validity of the patent has been tried on one or two occasions, but that he has never heard any question as to the validity of the patent?—I have not the slightest idea what Sir William Armstrong's patent is. It is quite clear that he cannot have patented anything in the words in which I had patented my invention before; he might have taken a patent for something else.

4673. *Chairman.*] This question was put to Mr. Clode last year: "Would there be any objection to lay the specifications before the Committee?" To which he replied, "The Act of Parliament prevents their being disclosed." "When was that Act passed?" "I believe it was the 22d Vict. chapter 13"?—Yes.

4674. Mr. *Laird.*] It is impossible to compare any specifications of Sir William Armstrong's with yours, because they have not been made public?—Sir William Armstrong's specification has been kept secret; the Act of Parliament forbids its being disclosed. It is possible that Sir William Armstrong may have some valid improvements, with which I am unacquainted, and he may have patented merely those improvements.

4675. But you know the way in which the guns were made?—Yes.

4676. *Chairman.*] Are they made on the same principle as your patent?—I can only tell you the words of Mr. Needham, the manager of the Butterley Company: when he saw them manufactured in the Arsenal, he said, "This is precisely the method of manufacture which we adopted for Captain Blakely, under his directions, in 1855." That was when my 9-pounder gun was under trial.

4677. General *Peel.*] But the Armstrong gun was in 1854?—I would wish it to be understood, that as to his first gun, although made in 1855, not 1854, he could not possibly have obtained any information upon the subject from me. No doubt we had, quite independently, arrived at the same conclusion. I do not suggest that he learned the thing from me in any way; I merely say that I laid it before the Government in 1854; therefore it might have been used in 1858 without the grant of a monopoly to other persons.

4678. *Chairman.*] But suppose that Sir William Armstrong had made this gun 20 years ago, it would not affect the question at all as to your having disclosed the same thing in 1854, and taken out a patent in 1855?—No.

4679. Captain *Jervis.*] Was your patent for a rifled gun, or merely for a method of strengthening?—Merely the method of making a strong barrel.

4680. Could not a patent be taken out for the same thing with a rifled gun?—I believe you may patent anything; a patent would be granted for almost anything; a gentleman might take out a patent for that inkstand on the Committee's table.

4681. *Chairman.*] And pay for the privilege?—Yes.

4682. Did I understand you to say that you objected altogether to the breech-loading principle, or merely to breech-loading for the larger guns?—I should think the breech-loading system would be very desirable, if we could get it; but I am myself not acquainted with any system on which I would place very great reliance. I am carrying on experiments, and hope to arrive at a satisfactory result. But

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my objection has been to the Armstrong breech-loader. My objection to that is, that the breech-plug is only a valve; and the first principle of every valve, whether the vessel contain water, or oil, or gas, is that the pressure of that fluid should press the valve tighter. Now, Sir William Armstrong's breech-loader is on a diametrically opposite system; nothing there confines the gas but the actual amount of labour expended in the screwing-up of the breech. If the gas is stronger than the man, aided by the screw, the gas will escape; if the man, aided by the screw, is stronger than the gas, it will be kept in.

4683. Have you any facts to adduce to corroborate what you have just been explaining?—Every one knows that the Armstrong breech-loader is not gas-tight.

4684. Now, have you any observations to make to the Committee with respect to the rifled guns constructed within the last few years?—I have stated that my great objection to those rifled guns is, that they cannot fire round-shot.

4685. Do I understand you to say that you now disapprove of the coil system?—I think it is now superseded by other and better methods of making hoops or cylinders, namely, the methods of casting them in one single piece of cast-steel, which cast-steel is afterwards very carefully hammered and annealed, and either rolled or turned, and bored to the requisite form.

4686. But putting aside the question about steel for the inner tube, is it not the fact that in the Armstrong gun the real source of strength is the coil system?—No; I apprehend that the real source of strength is in the method of putting the tension upon the outer parts of the gun, and not in the coil system. The difference of strength between a tube formed on the coil system and a tube which is merely what is called lap-welded would be as 4 to 3, or as 3 to 2 at the very outside; whereas the difference in the strength exerted by the outer ring of an Armstrong 100-pounder gun put on in a state of proper tension, and the strength which it could exert if put on without proper tension, is as 16 to 1; therefore the real source of strength is that tension, and not the method of making each individual hoop.

4687. But taking the Armstrong system as it exists, you do not controvert the fact, which has been proved before this Committee, that the guns constructed according to Sir William Armstrong's system are as strong as it is necessary for guns to be?—With respect to the 100-pounder Armstrong guns, they are extremely strong; but I merely state that their strength is attributable, not to the coils, but to the manner in which they are put together.

4688. General *Peel.*] In fact, their strength may proceed from what we are not allowed to look at, which is contained in the specification?—It may be so, but I think it is very unlikely, because I have seen the manufacture, and I think I should have discovered it. No one has found out Sir William Armstrong's secret yet; it is very well preserved.

4689. *Chairman.*] I suppose in the correspondence to be produced, we shall have everything that it is desirable for us to know with respect to your having brought your plans before the Government again since 1855?—I think I can give you that in a short form. I may say that I first brought my plan before the Government in 1854, and I patented it in 1855. I was an officer of Artillery, and I had no idea of a patent, or making any monopoly. I tendered it to the Government simply as a suggestion that occurred to me, and I did not take any great credit to myself upon the subject.

4690. Did you produce a gun in 1854?—No; I was then an officer of Artillery. I was so impressed with the importance of the thing that, at considerable expense, I went out to Balaklava, to urge Lord Lyons to let me strengthen some 10-inch guns of the fleet; for I was convinced (and I have now proved it) that we might then have filled shells with lead, and thus fired 150 lb. shots against those granite forts. One 150-pounder would have had ten times the effect of a 32-pounder, though only five times the weight; but I was discouraged, and there were no means of carrying that experiment out. I returned to England, and in September 1854 I again urged on the Duke of Newcastle the advisability of making some experiments; and I was once more referred to the Ordnance Select Committee, which, in July, had rather ridiculed my plans; so I thought the only thing to do was to make those guns. As the manufacture of guns is a matter of very great expense, I was obliged to take out a patent. It would have been impossible for me to get any manufacturer to take the trouble of making the experiments, unless I had been able to hold out hopes of introducing the manufacture, and of giving him some kind of monopoly; because, besides the expense of making the gun, the manufacturer is put to great inconvenience. There is as much trouble in making an experimental gun worth 50*l.* as in making 50 of them almost. The Butterley Company made those guns in the beginning of 1855. I have here the report of the trial of strength made by the Ordnance Select Committee of this very 9-pounder which they refer to in their report. I may say that I am not aware of any gun, either before or since this 9-pounder was experimented on, which has had the same amount of endurance. It was fired in competition with a common cast-iron service-gun and a brass service-gun. They were all fired a certain number of rounds, of which I will give you a table; the cast-iron gun fired altogether 351 shot, the brass gun 479 shot; and mine stood 3,389 shot, or seven times as many as the cast-iron gun, and five times as many as the brass gun.

4691. With what charges of powder?—The same charges of powder; but to give you an idea of the enormous endurance of the gun, I may tell you that the last 158 rounds were fired with double charges of powder, and as many shot as the gun would hold. Now, a strength of this kind cannot have been owing merely to the substitution of a couple of inches of wrought-iron for a couple of inches of cast-iron; it must have been something else, and the something else, I say, was the definite tension put on the outer rings, which enabled them to do double work.

4692. Was there any report made upon that result?—Unfortunately, those experiments went over two years, and the report was made in the beginning of 1857.

4693. Captain *Jervis.*] That was not a rifled gun?—No; that was a smooth-bored gun. Another gun which I offered to the Ordnance Select Committee failed. That was also a smooth-bored gun, and it was given to them before this one, so that the first gun which I gave to the Committee in March was not successful.

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cessful. The first gun had been badly bored; the boring-bit had come within half-an-inch of the central tube on one side, leaving two or three inches on the other. Even in that state it bore several rounds of firing, with charges of powder a good deal more than the service charge; still it was a failure.

4694. *Chairman.*] Will you now give the Committee an account of the manner in which you have brought your plans before the Government again, since that period?—Immediately on the great endurance of this nine-pounder being known to Lord Panmure, he ordered an 8-inch gun and a 10-inch gun to be made at the Woolwich Arsenal, on the same plan.

4695. You are still speaking of a smooth-bored gun?—Yes; a smooth-bored gun, merely to test the strength. Then these guns were made in 1857, but I was unable to have them tried.

4696. Why were they not tried?—I have a letter here from the War Office, dated the 27th November 1858, which shows the reasons why they were not tried: "War Office, 27th November 1858. Sir, I am directed by Secretary Major-General Peel to acknowledge the receipt of your letter on the 15th instant, and in reply, I am to inform you that the 68-pounder gun strengthened with rings on your system, is intended to be tried, in comparison with a 68-pounder gun, constructed by Mr. Holroyd, which has not yet been supplied. The trial of the 10-inch gun will take place as soon as some diaphragm shrapnel shells, which are being prepared to fire from it, are ready. I am to add, that due notice will be given to you of the time and place of these experiments.

"I am, Sir, your obedient servant,
"(signed) *Hardinge.*"

"Captain Blakely, R.A.,
Army and Navy Club."

4697. Captain *Jervis.*] Were those cast-iron guns strengthened with wrought-iron rings?—Yes.

4698. And you are satisfied now, are you not, that they would not have answered?—Those guns were afterwards tried, and they did answer. The 10-inch gun was fired 10 rounds with 20 lb. of powder and 130 lb. shot; then 10 rounds, with 20 lb. of powder and 264 lb. shot; then 10 rounds, with 20 lb. of powder and 394 lb. shot; then 9 rounds, with 20 lb. of powder and 512 lb. shot. That shows a pretty considerable amount of endurance; that was an 87 cwt. gun, and the 10-inch guns I am now making weigh nearly four times as much.

4699. Would you, with your present experience, be satisfied with a cast-iron gun, strengthened with wrought-iron hoops for the service?—If the Navy s determined to have a gun with such a small bore as seven or eight inches, I believe that a cast-iron gun properly hooped (not with wrought iron, because it would be absurd in 1863 to use wrought iron when we can get steel) would be perfectly efficient; and my reason is, not my own experiment, because I would not urge that upon you, but I would ask you to weigh the results of the experiments in France; the French do use those guns, and they answer very well.

4700. Are you aware that they have been utterly condemned lately by their own committee?—I think you are misinformed.

4701. Do you not know that a committee of artillery officers, who have met in 1863, think that plan was not a proper thing for the service, or, at all events, if you do not know that, would you think it very improbable?—I think that a gun made of steel throughout would be very much stronger; but the cast-iron guns being there, provided you limit the size to something under eight inches, I think it would be a better expenditure of money to rifle those cast-iron guns and strengthen them than to make new steel guns.

4702. I suppose that the making a cast-iron gun stronger is much cheaper than to make a steel gun?—Yes, very much.

4703. In your present manufacture of guns, do you use cast-iron or steel?—I make some of both; I think about equal quantities.

4704. But if cast-iron is so good, why should you go to the more expensive article of steel at all?—Steel is better, I admit that; but for the same expenditure, it is a question whether you will have one new steel gun, whose value may be put down, say as 100, or four altered guns, whose value might be put down as 75.

4705. Do you think that it would be advisable to strengthen the present 68-pounder smooth-bored gun, instead of making either new wrought-iron or steel guns?—That is my impression.

4706. *Chairman.*] Would it not be your impression that it would be better to do both?—Both; but I do not think that any 8-inch gun is of any possible use; it will not penetrate four-and-a-half inch plates, and I cannot conceive the use of arming ships or forts, which have to compete with four-and-a-half-inch plates, with that gun which will not penetrate them.

4707. Captain *Jervis.*] You consider that we ought to strengthen the 32-pounder?—The 6½-inch gun, whether made of cast-iron strengthened, or made of steel or brass, or wrought-iron, I think too small, and not of sufficient power to be of any great use.

4708. There being a great number of cast-iron guns in the service, are you able to say whether it is advisable to strengthen those guns so as to adapt them for the service, or to construct wrought-iron or steel guns?—My impression is that it would be better to strengthen those that we have, than to construct new guns of the same size.

4709. Mr. *Beecroft.*] I think you said that the French were making guns of cast-iron hooped with wrought-iron?—With steel.

4710. Are you aware of the quality of the cast-iron which they use?—My impression is that it is not equal to the best English cast-iron.

4711. Are you not aware that many of those guns are made of charcoal iron?—I think there have been a good many experiments, but my impression is that the English guns are better.

4712. Are you aware that the French are using charcoal-iron for casting guns?—I do not know that.

4713. If that be so, you must know very well that charcoal-iron is much superior to our cast-iron?—I am aware that the Americans, who are also strengthening cast-iron guns, use a good deal of charcoal-iron, which is very much superior to ours.

4714. *Chairman.*] In fact, the course pursued by the French and the Americans has been just what you suggest. They have been trying experiments with reference to new kinds of guns; but,

but, pending those experiments, they have been using, in the best way they could, their old guns?—Yes.

4715. If this country had pursued the same course it would, at all events, not have been in a position inferior to that of France?—It would have been in the same position. I have here a translation of a series of reports from Spanish officers to their Minister of War on this very system. On the 2d of January 1860 (this is a letter dated at the time at which we entered on our path of experiments), they say, "Cast-iron, by itself, as is clearly proved to us by the bursting of the guns we fired, is not strong enough to resolve the question of rifled cannon of large calibre unless the charge of gunpowder be much reduced, and even then it must remain subject to the distrust of the gunners; besides the difficulty of obtaining sound large masses of forged iron, that metal has not the necessary hardness for the bore of the gun. The path we must follow, then, is clearly indicated: cast-iron guns hooped, a most simple manufacture, which once established, only requires great care in bringing the hoops to the exact diameter. The difference between the diameters of the hoops and of the cast-iron part must be determined by calculation, aided by experiment"; you see they lay great stress on the exact tension. On the 27th of June I have another report on the endurance of one of those guns. "27th June 1860: Most excellent Sir,—The proof of the rifle cannon of 6½-inches bore, and weighing 62 cwt., has been continued since the last letter which I had the honour of addressing to your Excellency, and in which I reported that it had then been fired 500 rounds, with a charge of 6 lb. 9 oz. of powder, a wad, and an elongated projectile. It has now completed 1,000 rounds with the same charge. At the 967th round a steel vent-plug was inserted. The state of the gun is perfect" (the Spanish word which I have translated "perfect" is "*immejorable*"), "except a few scratches observed in the end of the bore, close to the vent, and caused without any doubt by the premature destruction of a vent-plug. God preserve your Excellency many years." That is signed "Gabriel Pellicer, First Commandant and Director."

4716. Mr. *Beecroft.*] Are those guns made of cast-iron?—Cast-iron hooped with steel.

4717. I suppose you know that Spanish cast-iron is of a superior quality?—I will send you a detailed report of the experiments made by the Spanish Government in 1861, with various kinds of cast-iron; they wished to know whether the English cast-iron or their own was the best for the purpose, thinking they could rifle cast-iron guns. You have here what they say, that cast-iron is not sufficiently powerful by itself; but they have found, with respect to the endurance of cast-iron, whether made in England or made in Spain of charcoal-iron or any mixture, that the endurance was a mere matter of chance. Some guns burst at the 19th round, and other guns, cast in a precisely similar manner endured, perhaps, 2,000 rounds; they found it was a mere lottery.

4718. Were the guns entirely made of cast-iron?—Entirely of cast-iron.

4719. Captain *Jervis.*] I asked you when then, with your present experience, you thought you could strengthen cast-iron guns, instead of making new guns of wrought-iron or steel, and I did not quite understand whether you consider that the present guns in the service should be strengthened. I think you say that the 68-pounder is not a very good gun, and that the 32-pounder is too small?—Yes.

4720. Then what gun do you consider ought to be strengthened and retained in the service?—I think they ought to be all condemned, and that we ought to make larger guns altogether.

4721. Therefore your view is not that of saving the present guns, but that we ought to cast a larger kind of gun?—I think we ought to make larger guns, and I should condemn all the present guns, including the Armstrong 100-pounders.

4722. And, for the future, instead of making guns of wrought-iron or steel, you would make them of cast-iron and strengthen them; is that your opinion?—No; if I were making a new 9-inch gun, I would make it entirely of steel.

4723. If we condemn what we have, you do not think we should start afresh with cast-iron guns strengthened?—I should recommend them to be of steel throughout, unless we go to a size beyond which we cannot get the steel; I am making 13-inch and 15-inch guns. Those 15-inch guns will weigh 50 tons, and I cannot get the steel for them; I have no choice in the matter; I must make the greater part either of cast-brass or cast-iron; I should prefer steel, and I have no doubt that next year I shall get it.

4724. When cast-iron goes, in what direction does it go, does it go inward to outward, or outward to inward?—It begins to break inside.

4725. Would any strengthening of the gun prevent that taking place?—It did so with this very gun; they went on increasing the charge of powder, and fired 366 rounds more with 7 lbs. 11 oz. of pounder, elevating the gun, and at the 1,366th round it burst. The Spanish officers were very much pleased with that result; but you will think that that was a still greater endurance when I read the words of that report; this is the report of two Spanish officers, reporting to their own Government.

4726. Captain *Jervis.*] Are you aware that the Spanish powder is very bad?—It gives very good ranges, taking pretty much the same weight of shot, and degree of elevation; it gives very much the same ranges as the Armstrong gun.

4727. Are you aware that it is considered remarkably indifferent compared with the English powder?—The results are the same.

4728. It gives the same range, do you say?—It does give the same range. With regard to the proof of this gun those officers report: "During the first days of proof 100 rounds were fired with intervals of only from 1 to 1½ minutes. This made the gun so hot that it could not be touched with the hand. The following day 50 rounds were fired in the morning and 50 in the evening, with the same rapidity." This is signed "Artemis Periz," and countersigned "Brigadier Director, Francisco de Elorza."

4729. Are you aware that considerable experiments have taken place in England with regard to cast-iron guns strengthened?—I am aware of that.

4730. What has been the result of those experiments?—I have given you the result of these experiments with those three guns of my own, and read to you a letter from the War Office, dated the 27th November 1858. I will read the concluding passage again: "I am to add that due notice will be given to you of the time and

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place of these experiments." That was never sent to me.

4731. Have you the result of those experiments?—I think I have stated that the gun was fired 39 times, with large charges of powder and large charges of shot; and the last nine shots fired from the 10-inch gun weighed upwards of a quarter of a ton, 512 pounds; and that was a very light gun.

4732. In consequence of that experiment you think that a good many guns were ordered to be strengthened?—I should be sorry to say that it was in consequence of that.

4733. But subsequently to that?—Yes, subsequently to that.

4734. And they have since that utterly failed, have they not?—They were strengthened by Sir William Armstrong, and not by me. Although the original experiments with the cast-iron gun were made for me, and although I was promised that "due notice," the 300 guns were ordered, and I never heard of the experiment till I saw it in the "Times" newspaper.

4735. Mr. *Laird.*] I suppose that the result of a trial of cast-iron guns hooped would depend on whether they were properly hooped or not?—I think so; and I think if you will look to this drawing (*producing certain drawings, vide Appendix*) of this block, which Sir William Armstrong prepared for hooping, you will not be astonished that they burst; I was not surprised. They were made thicker at the muzzle than at the breech. And I am not wise after the fact, because directly I saw one of those blocks, I wrote to say that the thing was so palpably wrong in shape that it must burst. I wrote to the Elswick Ordnance Company, to warn them that if they persisted in strengthening the guns in that way it would do my patent a great deal of damage.

4736. Sir *Frederic Smith.*] Whom was that section prepared by?—By a draftsman, to whom I gave the original drawing.

4737. Under your orders?—Yes; I got the original drawing in this way; as soon as seven or eight of the guns had burst, Lord Herbert, knowing that I had on a former occasion been successful, and probably then for the first time learning that I had brought the system of strengthening cast-iron guns prominently to the notice of the Government, asked me if I would go down to Woolwich and look at those guns, and try to strengthen them. I at once said that the shape was so very bad that it would be better to re-melt them.

4738. Colonel *Dunne.*] Those guns were made expressly for Sir William Armstrong's experiments?—Yes; 295 of those guns cost the Government 45,000 *l.*

4739. Sir *Frederic Smith.*] From whose designs were those guns made?—Sir William Armstrong's, I believe.

4740. Mr. *Laird.*] Were those guns which were tried in Spain, hooped according to your plan?—Yes; but the Spanish officers had no communication with me till after the experiments.

4741. Then were they hooped?—Yes.

4742. Were they the same as your plan?—Precisely.

4743. Have you a drawing of that?—Yes, I will give it in.—(*Vide* Appendix.)

4744. Were they hooped in the same way as those guns of Sir William Armstrong, which failed?—No; the general appearance of the thing would be very much the same; but the blocks cast for Sir William Armstrong were, in my opinion, quite of a wrong shape; and I will give you a proof that it is owing to the shape, and not to anything else, that they failed. Lord Herbert asked me if I could do anything with those guns, and I said it would be cheaper to remelt them; but that if he wished me to make experiments, and try to strengthen one of those guns, it would be rather an invidious thing to do, and I was afraid if I strengthened it in any other place, and it failed, I should be thought to have acted ungenerously to Sir William Armstrong. I said I feared I could not make a good job of it, and that my system would be condemned. I then made two express provisoes; one was that he should place at my disposal a 32-pounder gun, weighing 56 cwt. (this block weighing 70 cwt.), and let me treat both of them in precisely the same way. I further stipulated that the experiment should be carried on in the Royal Gun Foundries, so that no ill-natured person should say that I treated Sir William Armstrong unfairly. Those guns were afterwards tried, and the 32-pounder gun showed very much greater endurance than Sir W. Armstrong's. The 32-pounder gun was strengthened by me in exactly the same way as I strengthened this. I even bored out the old 32-pounder to the same size as this, in order to make the comparison more equal. I bored out that 32-pounder before rifling it, and that 32-pounder endured a very much greater amount of firing than Sir William Armstrong's gun. I will give you the exact result, which I have got here. The Armstrong block burst at the 84th round, of which 50 rounds were fired with a charge of eight pounds of powder, the shell weighing 67½ lbs.; afterwards 34 rounds were fired with 7½ lb. charge of powder, the shell weighing 90 to 221½ lb. The cast-iron service gun which was tried in comparison with this, both being strengthened by me in exactly the same manner, did not burst till the 133d round, being 50 rounds at Shoeburyness, with the same charge as the former gun; and then 83 rounds after that, and a test with increasing charges of powder, beginning with 5 lb. charges of powder, and a 48 lb. shot, and every 10 rounds increasing the weight of the shot, which of course makes the last 20 or 30 rounds a very much severer test than the first 100 rounds. This was fired altogether 133 rounds, as compared with the 84 rounds of the other gun. I should add (which will make this result rather more extraordinary), that the 32-pounder strengthened by me, with this very satisfactory result, was cast in 1799, and had been through the wars of the French Empire. It was on the point of bursting when I took it and strengthened it.

4745. *Chairman.*] Why did you select such an unfavourable gun for comparison?—It was selected for me, I took what I got. I remonstrated, but I was told that it was the only one I could have.

4746. Will you now proceed with your statement, so as to inform the Committee what guns you have brought before the Government since the year 1855?—At first, up to 1860, I had proposed only those experimental guns to prove the strength, but, in 1860, I also, seeing that the Government wished to have rifled guns, asked leave to compete for the production of rifled guns with Sir William Armstrong and Mr. Whitworth. I offered to conduct all the experiments connected

nected with my own gun at my own expense. I offered to accept as the programme of firing whatever was agreed upon by Sir William Armstrong and Mr. Whitworth with the consent of the War Department. My offer was refused. I have repeated that offer several times since, and have always been refused.

4747. Captain *Jervis.*] Refused to have what?—To be allowed to try.

4748. *Chairman.*] You state that you have not been allowed to compete by the Government of this country?—By the successive Governments of this country.

4749. What have you done for the Governments of other countries since that period?—Other Governments have been very glad to let me compete, and several of them have adopted my system.

4750. Have you any objection to state to the Committee what number of guns have been made according to your system for other Governments?—A great number have of course been made in foreign countries, by the officers in the arsenals of foreign countries; but in this country I myself have manufactured and supplied to foreign Governments about 400 guns.

4751. How many of those guns so supplied were steel, and how many were strengthened?—About one-half steel and about one-half strengthened cast-iron.

4752. What number do you think have been made, according to your system, in foreign countries?—Thousands.

4753. Will you state, generally, the numbers and calibres of the guns: First, which you yourself have made in this country; and secondly, the number which have been made according to your system, in foreign countries?—I can give you an accurate statement of what I have myself made, of course, which I will do.

4754. Captain *Jervis.*] Do they recognise your patent in France and Spain?—I have no patent in Spain.

4755. Did not the French make experiments many years ago, in strengthening cast-iron guns?—In 1840, I think, the French made a long series of experiments, with a view to strengthening cast-iron guns with wrought-iron hoops, and it failed, as utterly as did the very expensive experiments made in this country in 1859 and 1860, by Sir William Armstrong.

4756. Did you not offer in 1861 to make a 10-ton gun, 12-inch bore, to fire a 700 lb. shot with 70 lb. of powder?—Yes.

4757. Were you not told that if you could produce such a gun, and guarantee it, it would be ordered and paid for by the Government?—No, there was an addition to the stipulation. It was stipulated that I should first of all satisfy the Ordnance Select Committee (by showing drawings and giving explanations) that the thing was feasible, and I was then to get the gun manufactured and to guarantee it.

4758. The main point was, whether you could find a firm that would make the gun and guarantee it, was it not?—That I offered to do.

4759. Do you distinctly state that you offered to guarantee the gun, and that the Government refused?—I not only offered to guarantee it, but I offered to make it at my own cost, and to lend it to the Government for three months free of all expense.

4760. Sir *Frederic Smith.*] Shall we find that in the correspondence which is to be laid before us?—This was on the 10th of October 1860. It was when we were first beginning to make iron-clad ships, and my opinion being that 4½-inch plates were not shot proof, I wrote to "His Grace the First Lord of the Admiralty. Holywood, Belfast, 10 October 1860. My Lord Duke,—Seeing it stated in the newspapers that it is contemplated to build large steel-clad frigates, I have the honour to inform your Grace that I am acquainted with a simple plan of making cannon of sufficient power to render the proposed coating of these useless, if not worse. I am willing to supply her Majesty's Government with such guns, either at its expense, payment being contingent on the gun performing what I promise, or else at my own expense entirely. In this latter case I must stipulate that if I, at my own cost, produce a cannon which will save the nation several millions, by preventing the building of a certain class of vessels, Her Majesty's Government shall, on its part, test the capabilities of that gun within two months from the date I place it at its disposal; and, further, that the gun shall be returned to me ten days after the commencement of the firing. I can undertake the expense of the cannon itself only.—I have the honour to be, my Lord Duke, your Grace's obedient servant, *T. A. Blakely.*" Two days after I received the following reply: "Admiralty, S.W., 12 October 1860. Sir, I am directed by the Duke of Somerset to acknowledge the receipt of your letter of the 10th instant, and to inform you in reply that all communications on the subject of the construction of cannon should be addressed to the Secretary of State for War.—I am, sir, your obedient servant, *John Moore.* To Captain Blakely."

4761. *Chairman.*] What did you do then?—Then, on the 17th November, I not only offered to construct the gun, but I offered to lend the gun after I had constructed it, a 200-pounder gun.

4762. What reply did you receive?—The reply I received was that the gun could not be tested. I offered also in the same letter to contract for the supply of cannon at a rate less than that charged by the Elswick Ordnance Company, and the reply I got was, that neither the 9-inch gun could be tested, nor could my offer to contract for the guns be entertained, until the experiments pending with that 32-pounder and the 70-pounder Armstrong gun were completed; but as those were put on one side and not fired for two years, the time has never come.

4763. Mr. *Laird.*] You offered to do this at your own cost and risk?—At my own cost entirely.

4764. And you were refused?—Yes.

4765. I think you have said that you will inform the Committee the number of guns which have been made under your own direction in this country, and the number of guns which have been made in different foreign countries, according to your system?—I will put in an accurate return of the numbers made in this country, and an approximate return of those made in foreign countries, specifying whether they are cast-iron hooped guns or steel guns.

4766. *Chairman.*] Can you give the Committee any recent results of experiments with your guns?—I think there was a very extensive experiment tried at Charleston the other day; I was very much pleased with the result, in a scientific point of view. They were 9-inch guns, precisely similar to the 9-inch gun which I offered

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I offered to Her Majesty's Government in 1860. That gun was rifled in such a manner that it can fire round-shot; it loads at the muzzle. I know that the shot which were so effective at short ranges at Charleston were of spherical polished steel.

4767. Fired from your guns?—From guns either made by me, which have found their way there somehow, or else from guns made (and very ably made) by Captain Broke, of the Confederate Artillery, from models supplied by me.

4768. At what distance were the iron-clad ships from the batteries?—The "Keokuk," which was destroyed, was within 700 yards.

4769. What was the strength of the iron plates in that vessel?—My impression is that it was 4½ inches.

4770. Captain *Jervis.*] I have already asked you with respect to the offer made by you of a 10-ton 12-inch-bore gun to the Government: did you receive a communication from the War Office on the subject?—Yes.

4771. Have you got it with you?—I have got it here; it was on the 17th of November 1860 that I made the offer to the War Office: "I have now nearly finished a 9-inch gun." (I see I was mistaken when I said I had quite finished it.) "I have now nearly finished a 9-inch gun, from which I purpose to fire 200lb. shot. It will give me great pleasure to place it at your disposal for a period of two months, should you desire to know the powers of a gun of that size. I am, Sir, your obedient servant, (signed) *A. T. Blakely*, Captain.—To the Right Honourable the Secretary of State, War Office, Pall Mall." The answer is dated 12th December 1860: "War Office, 12th December 1860. With regard to the offer to supply guns which you have made, I am to inform you that it cannot be considered until the experiments with the other guns are concluded." Those guns are the 32-pounder and the 70-pounder.

4772. *Chairman.*] And two years were expended in trying those experiments?—A little more. The firing extended over a couple of hours; the rest of the period was devoted to seeing what effect the weather had on them, I suppose.

4773. Captain *Jervis.*] It was subsequently to that, that you had an interview with the Ordnance Select Committee?—Yes.

4774. And you then made an offer of a 10-ton gun with a 12-inch bore?—Yes. I have got the answer from the War Office, dated the 16th February 1861: "Should you be able to induce any firm, of known character, to tender to supply a 12-inch gun capable of enduring a service charge of one-tenth the weight of its projectile, or 70 lbs. of powder, and a proof-charge of two-tenths, and of a weight not exceeding 10 tons, his Lordship will be prepared to take such tender into his consideration. It will, however, be necessary that the drawing from which this gun may be made should be approved by the Ordnance Select Committee, and that the firm tendering for its supply should guarantee its efficiency in all respects, as a condition of payment." I agreed to the latter part of that letter.

4775. *Chairman.*] Will you be so kind as to give us your reply to that letter?—I do not think I have got it; but it was to the effect that I would guarantee the efficiency of the gun, but that I could not undertake to satisfy the Ordnance Select Committee.

4776. Mr. *Laird.*] But in the correspondence, if this Committee obtain it from the War Office, your reply would of course be shown?—Yes.

4777. Captain *Jervis.*] I understand you to state that you objected to your drawings being submitted to the Ordnance Select Committee: what was the nature of your objection to that?—In the first place, I had, a few days previously, had an interview with the Ordnance Select Committee, for the purpose of making the offer which I, in fact, made; and I had then answered all the questions which they had asked me, and thus ascertained the impossibility of obtaining their approval of my plans. I rather thought that this letter was simply for the purpose of obtaining time—putting me off, in fact.

4778. When you had that interview with the Ordnance Select Committee, it was your own proposal to make the gun in question, was it not? Precisely.

4779. With the weight which you have mentioned, and to stand the charge which you have mentioned?—Yes.

4780. And you were then told that if you could find a firm that would guarantee the making of that gun it would be taken?—The Ordnance Select Committee can only make recommendations.

4781. And you then received a letter, in which was named the condition that the drawing for the gun must be approved by the Ordnance Select Committee?—Yes.

4782. Then what objection had you to submitting your drawings to the Ordnance Select Committee?—I really did not think that submitting the drawings of the gun to the Ordnance Select Committee would have resulted in their approval of the gun.

4783. That, of course, is only your own opinion?—I certainly do not think that the Ordnance Select Committee who were sitting in 1861 would have approved of the gun.

4784. Do you not think it would have been a more simple plan to submit drawings first, and then see if you had any ground for that opinion?—I confess that my former communications with the War Office had not been treated in the way which I expected. I thought that after I had offered to place a gun at their disposal for trial, and not receiving any payment for it unless the gun was successful, it would be quite time enough to tell them how the gun was made if they approved of it.

4785. Mr. *Laird.*] Was it because you believed Sir William Armstrong was the adviser of the Ordnance Select Committee that you objected to submit the drawings for their approval?—That was my principal reason.

4786. You are aware that he was appointed Engineer for Rifled Ordnance?—Yes.

4787. You are aware that his instructions state that he shall conduct all experiments and investigations which may be sanctioned by the War Department for the purpose of developing his system, or for the improvement of rifled ordnance generally.—Yes.

4788. Did that raise an objection in your mind to submit the detailed plans of your gun to the Ordnance Select Committee?—That was my reason. The drawings which I had before supplied for the strengthening of the 32-pounder gun represented very faithfully the 100-pounder Armstrong gun which was afterwards introduced into the Service.

4789. You were also of opinion that, having offered

offered to make the gun and have it tried at your own risk, that offer was sufficiently liberal without having added to it the condition that you should submit your plans to the Ordnance Select Committee, where they might, you thought, get into the hands of an inventor who was a competitor with you?—That was my reason.

4790. Sir *Frederic Smith.*] You felt, I suppose, that your system ought to be tried without being submitted to any criticisms or alterations from other people?—I thought, and I think, that considering I had offered that the Government should not be put to any expense about the matter, that offer was quite sufficient. Besides, I did give the Ordnance Select Committee a full description of the principle on which I was going to make the gun.

4791. Captain *Jervis.*] Then having given them all the information which you could possibly give them, what objection could you have had to lay before them those drawings, from which they were to learn nothing new?—I thought the thing would be refused from me, and that I should be told my plans were bad. I thought some little alteration might be made, and that it might have been copied and represented to the country as an Armstrong gun.

4792. Were you not perfectly aware that Sir William Armstrong was not the adviser of the Ordnance Select Committee?—I should certainly think he was.

4793. Was your gun to be a rifled gun?—It was to be a rifled gun, certainly; to throw a 700-pound shot.

4794. From your experience of the Ordnance Select Committee whilst you were in the service, and from your knowledge of the men on the Ordnance Select Committee, are you of opinion that they would have been biassed by Sir William Armstrong, with respect to any plan submitted to them by yourself?—I have intimated no suspicion of the kind.

4795. General *Peel.*] Sir William Armstrong was not a member of that Committee, was he?—No.

4796. Colonel *Dunne.*] But quite apart from yourself, do you think that the Ordnance Select Committee ought to take any offer that is made to them of a gun, without making any previous examination as to its probabilities of success?—I do think that any offer made by an artillery officer of tolerable experience should have received consideration, particularly when that officer had proposed to bear all the expense. I think my doing so was a great guarantee of my good faith.

4797. That has reference to yourself; but leaving you out of the question, and taking it generally, do you think it would be advisable for the Government of this country to have a Committee who would receive any gun that was offered to them, merely because the proposer of the gun volunteered to be at the expense?—Yes; I think that would be very desirable. In the Government of the United States, that is the course pursued. Anything whatever, no matter how palpably absurd, which is brought before that Committee, is tried, provided the inventor will bear the expense; and they adhere to that system, and find that it answers.

4798. I do not at all mean to suggest, with regard to yourself, as a gentleman known to have had experience in gunnery, and being an officer of the corps, that it might not have been unreasonable to refuse your offer; but do I clearly understand you to say that you think any inventor, however chimerical his scheme might appear, should not be required to send in a statement of the outline of his invention before it was tried?—My opinion is, that it should be tried, however chimerical it might appear.

4799. Without the Committee having a statement of the construction laid before them?—I think it would be quite time enough to do that when the thing was approved.

4800. To pass to another subject, I think you said, did you not, that spherical shot would be more effective than elongated shot, at short distances?—Not that it would be more effective, but that the gun would be more easily loaded.

4801. The initial velocity of a spherical shot is greater than that of an elongated shot, is it not?—The initial velocity is greater, but the force of the blow given is not measured by the initial velocity only, but by the square of that initial velocity multiplied by the mass; and the *vis viva* would be very nearly the same, whatever might be the length and the weight of the projectile, provided the same charge of powder were fired from the same gun.

4802. At what distance do you think the square of the initial velocity multiplied into the weight would be as effective with a spherical projectile as with a rifled projectile?—I think, taking the 9-inch gun, which is a very good standard, I should prefer using elongated shot with a charge of 40 lbs. of powder at all distances over 400 yards.

4803. It has been stated before this Committee that naval warfare will, for the future, be carried on at about the same distance as that at which it has hitherto been carried on. Now, in your opinion, would not a spherical projectile be perfectly efficient at 400 yards, which is about the distance in question?—By practice as a manufacturer, and as a cannon merchant (which I now am since I left the Artillery, and also in consequence of my not having been allowed to compete), I find that foreign naval officers prefer a proportion of about an equal number of polished spherical steel shot, and elongated steel shells, which leads me to suppose that they apprehend that one form of projectile will be about as useful as the other, and as frequently put into requisition.

4804. For the same purposes?—For the same purposes, and supplied with the same guns for the same ship.

4805. You think that you could use the gun first with one kind of shot for chase purposes, and then with the other kind at near quarters?—Yes; the French navy is armed with guns rifled in such a manner that they can fire round-shot, and the consequence of the difference between the French gun and the English gun is, that the French can place a very much larger proportion of rifled guns on board their ships than we can, because our naval officers do not like the Armstrong breech-loading finely-grooved gun for firing between decks.

4806. Are the spherical and the elongated shot both coated with lead in the French Navy?—No; the spherical shot is a perfectly smooth sphere of steel.

4807. Then in the rifling, there is no advantage with respect to that shot?—None whatever.

4808. Would not there be a disadvantage from the increased windage?—Very slightly; if you put

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put a few extra ounces of powder in, you make up for all that.

4809. And those, I understand you to say, are the guns that you recommend?—Yes.

4810. Are those the guns that you make now?—Those are the guns which I now make a good many of; almost exactly the same gun as the 9-inch bore gun, which I offered to Her Majesty's Government on the 17th of November 1860.

4811. Do you not think that our 32-pounder, and our 68-pounder, strengthened by hoops, would be sufficient for this distance, for 400 yards?—I think the calibre is too small.

4812. You think you must have a larger gun?—I think we must have a larger gun.

4813. Then you must increase the weight enormously, must you not?—The 9-inch gun weighs about 10 tons, and there is no difficulty in moving it.

4814. What should you say was the limit of weight for a gun in use on board ship?—I think that the calibre on board ship should be measured by the work which it has to perform, and that we should, in all cases, choose the smallest gun which would do the work required. For instance, if we had to penetrate a 4½-inch iron plate, we having discovered that the 68-pounder is not efficient for that purpose, should discard the 68-pounder. I would then make experiments with the 100-pounder, or a gun a little more powerful, and take the least gun that will effectively penetrate those plates. I would reject every gun that was not capable of doing the work that it was called upon to perform.

4815. What is the largest gun you have ever made?—The largest gun I have ever made is 12¾ inches in the bore.

4816. And the weight?—About 27 tons.

4817. And could such a gun as that go on board ship?—Yes; I think a ship should only carry, at most, two of them. In a revolving turret, the weight would not be greater than the weight of two 9-inch guns.

4818. That would be in mid-ships?—Yes.

4819. Then the ship could carry no other armament on the upper deck than one of these guns, and one of the others?—Just so.

4820. Do you think that would be sufficient for warlike purposes?—If the enemy has a coating which cannot be penetrated by a smaller gun, we have no chance but to use a larger gun, or none.

4821. But would not that be an exceptional case; could you fit out a fleet for service with that kind of gun?—If the enemy has a ship plated with 4½ inches of iron, then I think that England should either give up cannon, and fight with musketry, so as to pick off the enemy's men at the port-holes, or else arm the ships with guns capable of piercing the enemy's plates. I am quite sure that if the "Warrior" came up alongside "La Glorie," that the 68-pounders of the "Warrior" would not injure "La Glorie."

4822. But there is no reason, is there, why the "Warrior" should not have rifles to fight with?—The 68-pounder smooth-bore is of no use against iron-plated ships.

4823. What is the armament of "La Gloire"?—She has 6½-inch rifled guns, of a weight of about five tons.

4824. What is the weight of the shot?—The guns throw bolts weighing 99 pounds.

4825. Are they old guns strengthened, or rifled?—They are rifled, I believe. I think every one of them, so as to be able to fire smooth round shot if necessary, or a steel bolt which they have for the purpose of firing against iron-clad ships, which weighs 99 pounds, and which it has been found by experiment will pierce a target representing the "Warrior," if placed vertically before it, at upwards of a 1,000 yards distance.

4826. Is that bolt a shell?—I believe they have made experiments with shell, but that I cannot say with certainty.

4827. Do you think that bolts going merely through the side of a ship would have any great effect unless they were shells?—A bolt in order to have effect against an iron-clad ship should have sufficient force to go in at one side and knock the plate off the other side. The real damage would be at the further side of the ship, and I think that would be better than firing shells, because the charge of powder which can be put into a shell which was sufficiently strong in the crust to penetrate iron plates would be very small.

4828. Do you think any gun in existence would go through the "Warrior's" side and knock the plate out of the other side at 1,000 yards?—No; but at 300 yards it would.

4829. You think that the armament of the "Warrior" would not be effective at that distance against "La Glorie"?—It would bend the plates a little, and nothing else.

4830. What is the strongest gun on board the "Warrior"?—A 68-pounder.

4831. Rifled? — Smooth bore. The 110-pounder Armstrong at distances over 600 yards is more effective than the 68-pounder, but I think the "Warrior" has only eight Armstrong guns.

4832. But taking the distance, say at 400 yards, do you think the Armstrong gun would not have the same effect on the armament of "La Glorie" as a French gun would have?—I think not.

4833. You think that the French gun then is superior to the Armstrong gun?—I am sure of it.

4834. *Chairman.*]—Can you state what was the weight of those guns to which you have referred as having been used at Charleston the other day?—About nine tons.

4835. Sir *Frederic Smith.*]—What was their bore?—Nine inches. There were very few of them. The principal arm that was used was the 7-inch gun.

4836. Have you any knowledge of the effect of those guns on iron-plating?—I have no written report; but an eye-witness tells me that at Richmond, in the Confederate States of America, he saw one of the 7-inch guns shoot through three 2-inch iron plates placed one behind the other.

4837. At what distance was that?—That was at a distance of 200 yards.

4838. Colonel *Dunne.*] The American iron plates are understood to be very bad, are they not?—I do not know; but those particular plates were made at Sheffield.

4839. Have you ever turned your attention to the subject of the field-gun?—Not much; I have made them. In fact, General Stuart's cavalry are armed with guns made by me; muzzle-loading guns; the shells weighing 12 lbs., the guns 5 cwt.

4840. Are

4840. Are they concussion shells or time shells?—Concussion shells.

4841. You are aware of the make and execution of the Armstrong guns in use in our service now?—Yes.

4842. Do you consider those guns efficient field guns?—They are very good field guns.

4843. Do you know of any better gun which you would recommend for adoption into Her Majesty's service at this moment?—I think that any muzzle-loading gun would be an improvement. I think that even for field guns they might be rifled, so as to fire round shot as well as elongated shot. I think also that the ricochet firing is of great importance.

4844. You think that the loss of ricochet firing is of great moment?—Yes; even in the field I think so, though that is not so much the case there as in the naval service. And not having guns which can fire round shot, we are forced to take into the field smooth-bore guns and rifled guns, whereas it would be very easy to combine the two things.

4845. Have you not in the Armstrong gun the advantage that you are saved the trouble of taking grape shot, by your having a shell which will burst at the muzzle of the gun?—I doubt if anything could ever replace grape shot or canister.

4846. Do you think that the effect of canister is superior to that of the Armstrong shell, even now when it bursts?—Yes, I think so.

4847. At what distance?—Canister is only used at close quarters, of course.

4848. Had you not, under the old system, the trouble of carrying different kinds of ammunition, whereas in the Armstrong gun you have a missile which you can use either as a solid shot or as canister?—Sir William Armstrong has done the country great service by his admirable arrangement of the shell in that respect; but I do not think any very great confusion could ever arise by having supplies of canister; the shape of the two things is so different.

4849. I do not refer to the possibility of confusion, but to the trouble?—The weight to be carried would be but small.

4850. You do not think that the advantage derived from the discovery of a shell that can burst at any distance, and which you can use as a round shot, compensates for the loss of ricochet firing, and the other advantages of a smooth-bore gun?—I should like to have a gun which would do both.

4851. Could a gun of that kind, in your opinion, use the same shell as Sir William Armstrong's?—I think that Sir William Armstrong's improvements in shell could very easily be adapted to a muzzle-loading gun.

4852. Would you have round shot coated with lead?—No.

4853. Then you would lose the advantage of the rifling, as far as the spherical shot went?—Yes.

4854. Do you think there would be any advantage in using a gun more simple than that of Sir William Armstrong, which a muzzle-loader must be?—It must be much simpler.

4855. Do you think there would be any difficulty in the field from the want of skilled artillerymen, to take the place of those that were killed?—I am quite sure that the breech is a very weak point in those guns, and must break down very often.

4856. Even in the smaller guns you think that is the case?—Yes.

4857. Have you seen any returns on that subject?—I have not followed them much.

4858. Mr. *Beecroft.*] I think you stated that the French had stopped building fresh iron-clad ships?—That is my impression.

4859. What grounds have you for making that statement?—I have been told it on very good authority, but it is a matter which of course can be very easily ascertained. We have an officer over there whose duty it is to report such things.

4860. *Chairman.*] I think what you stated was intended to be confined to the laying down of new iron-clad ships?—No vote has been taken in the Naval Estimate for new ones since they found they could be penetrated with a light gun at a thousand yards.

4861. Mr. *Beecroft.*] When you went out to Balaklava and applied to Lord Lyons for permission to strengthen the guns on your plan, did you take with you any machinery or appliances which would enable you to carry out your suggestion?—It could have been carried out in the arsenal at Constantinople, or it could have been carried out at any workshop in Constantinople; it is a very simple question.

4862. *Chairman.*] There was a floating workshop at Balaklava, was there not?—Yes; it would have been a very easy thing to do.

4863. Mr. *Baring.*] What was the charge of that 6½-inch French gun?—Twenty-seven pounds when piercing iron plates.

4864. What is the weight of the gun?—Five tons, I think.

4865. Is it a steel gun?—No; I should say that two-thirds of the whole weight of the gun is cast-iron, to which steel rings are applied, and put on with a very carefully ascertained degree of tension. The steel rings are made too small to go over those cast-iron guns without being expanded by heat, and the closest nicety is required in adjusting that difference of diameter. If the rings are the least bit too small, the whole force of the strain is thrown on the rings; but if they are the least bit too large, there is great risk of the cast-iron splitting up inside the rings.

4866. Do you know whether they have stood any very large quantity of firing?—Yes, very large; one gun especially, the gun whose endurance recommended the adoption of the principle into France, was fired 3,000 rounds with one charge of powder and three shots, which was of course a most remarkable case of endurance. Long before the end of that time the gun was no longer serviceable, but it did not burst till the 3,000th round.

4867. You have stated, I think, that your disinclination to show the drawings of your gun to the Ordnance Select Committee arose from your belief that another drawing which had been shown to them had been used for the purpose of constructing an Armstrong gun?—No, I think not. I did not suppose that any drawings supplied by me to the Ordnance Select Committee would be so used. The position of those officers precludes the possibility of such a thing.

4868. Then what was it you meant to imply: I thought you said that one of your drawings was afterwards represented in a 100-pounder Armstrong gun?—I made a gun in the Arsenal; any person might go in and see it. The similarity between it and the Armstrong 70-pounder was so great that I could not tell one from the other.

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I was in Woolwich Arsenal at the end of 1860. I went down day after day very often to look at the gun in preparation; that was the gun which Lord Herbert asked me to strengthen; and one day I went up to the lathe, and thought it was finished, but the workmen said: "This is not your gun; it is a gun of Sir William Armstrong's."

4869. What was the date of your having sent in the plan for the construction of this gun?—August 1860.

4870. It was in 1860 that your gun was being made in Woolwich Arsenal?—Yes.

4871. Do you attribute the form of the 100-pounder Armstrong gun to suggestions obtained by Sir William Armstrong from seeing your gun when in process of manufacture?—At the time I had that suspicion.

4872. But you do not think so now?—No; I think it was not so; but that was what influenced me at that time.

4873. You now do not think that Sir William Armstrong adopted the form of his 100-pounder gun from that drawing?—It is impossible that he could have done so. I apprehend that he had fixed its form before.

4874. I think also you said that you were influenced in your decision not to submit the drawings in question by the knowledge, or by the idea, that Sir William Armstrong was consulted by the Ordnance Select Committee as to reporting upon the designs of other inventors. Did I understand you correctly to say that?—Not in reporting on the inventions of others; but I apprehend that it would have been his duty to give advice to the Committee on any matter connected with rifled ordnance.

4875. Before you refused to send in your drawings to the Ordnance Select Committee, had you seen the memorandum of instructions to Sir William Armstrong, which an Honourable Member has quoted to you?—No; I merely know what is the plain common-sense view of the case. If I had an engineer in my pay, and if any proposal was made to me with respect to engineering works, I should consult him about them.

4876. You do not know whether it was the practice of the War Office to consult Sir William Armstrong in such cases?—No; but if they did not, they certainly should have done so; that is my opinion. I thought they ought to have consulted him upon any matter connected with rifled ordnance.

4877. Sir William Armstrong's instructions were these: "Sir William Armstrong, in cases where questions relating to rifled ordnance shall be referred to the decision of the Committee, shall, if required, act under the direction of such Committee." You are not aware that such orders or requirements were given to him, are you?—It is clear to me that there would have been no impropriety if the Government had submitted my drawings for the approval of Sir William Armstrong.

4878. My question relates, not to the subject of the impropriety, or the reverse, but to the fact only?—I was under the impression that they would have been submitted to him.

4879. And that feeling prevented your sending your drawings in?—Yes.

4880. If that course had been pursued, it would have been an obstacle to your submitting drawings?—Yes; the mere suspicion that it would have been pursued, prevented my sending in my drawings. I preferred going to the great expense of having an actual gun made, the expense not being less than 4,000 *l.*, in which the construction could not be seen; I say I preferred sending in that gun to sending in those drawings upon which the actual construction could be seen.

4881. Do I understand you to say that you think you have not been dealt with fairly by the War Office, from time to time?—I think there has been some little confusion in the War Office in the matter. I think I have had distinct written promises, which have not been kept; and that can only have arisen from forgetfulness which, again, can only have arisen from confusion.

4882. Are there any other points which you wish to explain to the Committee in respect of the conduct of the War Department, of which you complain?—I make no complaints.

4883. Then, will you permit me to ask you, with respect to your assertion of the confusion in the War Office, and promises not being kept, whether there is anything which you wish to produce, in order to substantiate that opinion, or in any way to explain that statement?—No.

4884. Have you already stated to the Committee the promises which, you allege, have not been fulfilled to you?—One promise was, that I should have information of the time and place of firing those guns which were prepared in 1857, and which were fired afterwards in 1859, but without any notice. Then with regard to the 32-pounder, and the 70-pounder Armstrong gun, which I strengthened for competition, a promise was given to me by Lord Herbert in 1860, that they should be tested immediately, but they were not tested for two years.

4885. Was that promise of Lord Herbert given at an interview, or in writing?—At an interview; by-the-by, I am not quite sure that I have not got it in writing at home.

4886. Was there any other promise which has not been kept?—There was another one, and rather an important one. It was this: When I consented to strengthen those defective cylinders, I stated at once that I did not think I could undertake to do them, unless upon one condition, namely, that if those failed, my system of strengthening was not to be condemned on account of the failing of them. Two years afterwards, this having been forgotten, when the Armstrong gun burst, it was marked very legibly in white paint with the name of Captain Blakely, and was shown for months last year as being one of my guns.

4887. You think that was hardly fair?—It must have been done by mistake; probably by the order of one of my brother officers, who would rather have injured himself than me.

4888. Then the first promise that was broken had relation to the time of the firing of certain guns?—Yes.

4889. And the second one had relation to trials which did not take place so soon as you understood they would take place?—Yes.

4890. And the third related merely to the marking of a gun?—Yes; and if you will permit me to say so, that is rather an important point.

4891. Is there anything else in the conduct of the War Office with respect to your different proposals which you wish to bring before this Committee?—No, there is nothing else; and I should not have mentioned those points if I had not been asked.

4892. Mr. *Laird.*] Will you kindly read to the Committee the 3d, 5th, and 6th paragraphs of the definition of Sir William Armstrong's duties?—"He shall conduct all experiments and investigations

investigations which may be sanctioned by the War Department, for the purpose of developing his system, or for the improvement of rifled ordnance generally. He shall report and advise upon all questions submitted to him by the War Department in relation to rifled ordnance. In cases where questions relating to rifled ordnance shall be referred to the decision of a Committee, Sir William George Armstrong shall, if required, act under the direction of such Committee."

4893. Do you think that was a fair position for an inventor to be placed in with respect to other inventors like yourself?—I think that no inventor should be placed in the position of Sir William Armstrong. If I had myself been placed in the same position, I think it would have had the same effect on other inventors as it had on me.

4894. *Chairman.*] To what do you attribute the unsatisfactory state of our knowledge in matters connected with the larger classes of rifled guns, after so many experiments have been made, and such lavish expenditure has been incurred?—I think one great reason is, that we have had an inventor as director of rifled ordnance, so that very many persons (I am not alone) have objected to sending in their drawings. I think also, without reference to that point, that the experiments have not been carried on in the exact direction in which they should have been carried on. In order to discover which was the best rifled gun of a given diameter, it would have been better, in my opinion, to rifle several guns of the same diameter, of the same length, and the same weight, on different plans; and for proof that that would have been a judicious mode of proceeding, I need only say that the Government are going to do that in 1863, after being four years making experiments on one system, or rather on two systems of rifling only. In other words, they are now going to do that which I, as as an individual, did many years ago.

4895. They are now going to do that, after the expenditure of two millions and a half of money?—After the expenditure of whatever the amount may be.

4896. I think you state that all your experiments were carried on at your own cost?—Yes.

4897. And none of Sir William Armstrong's experiments were carried on at his own cost, were they?—The experiments of Sir William Armstrong and Mr. Whitworth were carried on at the expense of the country.

4898. Mr. *Baring.*] You say that you think the Government ought, in the first instance, to have carried on a greater number of experiments in order to test different systems of rifling?—Yes.

4899. How long do you suppose would be occupied; first of all, in preparation, and, secondly, in carrying out the experiments?—I should say two months.

4900. You think, for instance, in the year 1859, when the Government of the day adopted the Armstrong system for field artillery that, instead of adopting that at once, there should have been experiments made to test different systems of rifling?—That is my opinion.

4901. And you think the report of Colonel Mitchell's Committee, and the report of the previous Committee, taken altogether, were not sufficient for the guidance of the Government?—No; I think not. One great mistake, if I may be permitted to say so, was, I think, the serious one of keeping all the experiments secret, and shutting out the intelligence of the country. I think, on the contrary, that publicity ought to have been sought. The fact is, that this is one of the very simplest of things, and the proof that rifled guns are easily to be made is found in the fact that every person who has tried it has succeeded tolerably well. In all those cast-iron guns that were tried the other day, there was, really, practically, no difference in the shooting of any of them.

4902. At the present time, there is no secret about any of the experiments that are made?—None.

4903. There are hundreds of people on the ground where the experiments are conducted?—Yes.

4904. And the results are published in the "Times" newspaper?—Yes; but that was not so in 1859 or 1860. In fact, an artillery officer could not go into the Royal Arsenal. I believe that was so for three years.

4905. Mr. *Beecroft.*] I think you stated that Mr. Whitworth's experiments were carried on at the expense of the country?—That is my impression.

4906. You are not aware that a great many of them were carried on at his own expense?—I think not; but that may have been so: at all events, he has had many tens of thousands of pounds spent on his experiments.

4907. Are you aware that we have it in evidence before this Committee that he spent a very large sum of money in experiments himself?—He may have done so.

4908. *Chairman.*] You have been a good deal connected with foreign governments with reference to this subject; has any foreign government to your knowledge adopted Sir William Armstrong's system, or any other system like it?—Sir William Armstrong's system has been tried in Russia, in Turkey, in Austria, and in America. There was one very curious circumstance with respect to the trials in America, which is this, that the Armstrong gun made in America shot a good deal better than the Armstrong gun made in England. The fact is that they had not in America very accurate details of the manufacture; they only knew the system generally; the consequence was that they made some slight alterations in the thickness of the lead, or something of that kind, and produced a better gun, and yet they would not have it. The Whitworth gun has been tried in France, and rejected. At an elevation of 5 degrees, out of 10 shots they found that some shots went as much as 570 yards further than others. The Whitworth gun was tried at Copenhagen, and the 32-pounder burst and killed poor Lieutenant Colson. Last year it was tried at St. Petersburg, and two months ago a 35-pounder, which was sent there last year, burst at the 149th round, fired with 5 lbs. of powder and a 35 lb. shot.

4909. Colonel *Dunne.*] Are you aware of any difference which may be produced upon the guns by changes of temperature in passing from the climate of one country to the climate of another?—I think it likely that a very severe winter would try them.

4910. Have you heard anything about our own guns that went to America?—No.

4911. *Chairman.*] But the fact is that neither Sir William Armstrong's nor Mr. Whitworth's systems, although they have been tried in many foreign countries, have been adopted by any of them?—

Capt. *A. T. Blakely.*

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them?—With the exception of the Brazils. I believe the Brazils have adopted the Whitworth gun for field service, but Mr. Whitworth will give you information about that very much better than I can. I suppose he has the actual report of the Russian and French trials. I have myself got the report of the French trials, but I obtained it indirectly.

4912. Will you kindly put that in?—I cannot give you my authority for it, but I can give you the report which I myself copied from the original.

4913. I think you stated, in answer to an Honourable Member just now, that you thought the proper way of arriving at the right gun for Her Majesty's service, would have been by testing the different systems that were proposed, one against another?—Yes; testing the systems, not the individual guns.

4914. The systems, and not the guns; because one manufacturer might of course make a gun better than another manufacturer. You think the plan ought to have been to test the different systems, taking guns of the same calibre, the same weight and so on, they being made in the same place, and by the same man, and being tried one against another?—Yes, and taking several of each kind, because there is a great deal of uncertainty in guns. With respect to cast-iron guns, it is a mere lottery. There were five or six cast-iron guns rifled, and tried one against the other for strength; and, if I understand the report of the Committee rightly, they arrived at the conclusion that the gun which burst most easily was rifled upon the plan which tried the gun the most severely. But that does not follow at all; the very system of rifling which tried the gun most, may by chance (and a very probable chance) be the strongest. It is well known that out of several cast-iron guns cast at the same time, the same place, and with the same metal, one will endure very much more firing than another.

4915. Mr. *Laird.*] You have been asked about the introduction of the Armstrong gun for field service; are you aware of the amount that was taken in 1859 for the field service guns?—Yes; my impression is, it was 50,000*l.*

4916. £.70,000; but that is a very different thing from spending two and a-half-millions on one gun?—Yes; if I might venture to give an opinion, I should say that the 70,000 *l.* was judiciously expended, because we obtained 70,000 *l.* worth of guns for our money; and if we found out afterwards, when we had spent our 70,000 *l.*, that there was a better gun, there would still have been time to discard that and take a better.

4917. The course actually adopted was that of shutting out inventors from having their inventions tried?—Yes, and not only that, but the monopoly to the Elswick Company prevented other manufacturers bringing their experience to bear upon the subject. So early as 1855 I took an offer to Lord Panmure from the Butterley Company to make those coiled guns.

4918. Without any guarantee?—None at all; they only said they would not undertake to make less than 12, because they had to put up a great long furnace. I may state that I felt so much that every system of rifling ought to be tried, that Mr. Bashley Britten, having applied to me quite early in 1859 for permission to have a cast-iron gun strengthened on my plan, in order to give him a fair means of competing with Sir William Armstrong, I myself wrote to the Government of the day to say that if they would send me a 32-pounder, I would strengthen and rifle it on Mr. Bashley Britten's plan, and return it free of all cost.

4919. Your opinion is that it was judicious to spend 70,000*l.* upon that field gun, but not to spend two and a half millions on other descriptions of guns?—No; and I think the experiments with other guns should have been continued, and even more so after the Armstrong gun was adopted.

4920. Other persons being allowed to bring in their inventions?—I think the experiments should have gone on indefinitely, but that they should have been pushed on very much more after the adoption of the Armstrong gun into the field service, because it was then of much more vital importance to us to ascertain which was the best system, since every day we were put to great expense.

4921. Mr. *Baring.*] It is the fact, is it not, that very much more extensive experiments have taken place since the introduction of the Armstrong gun than before its introduction?—They are going to make them now.

4922. Have you seen the Report of the Ordnance Select Committee?—I have seen no reports of experiments which, in my opinion, were worth anything.

Lunæ, 29° *die Junii*, 1863.

MEMBERS PRESENT.

Mr. Baring.	Mr. Laird.
Mr. Beecroft.	Mr. Monsell.
Colonel Dunne.	Sir Morton Peto.
Marquis of Hartington.	Major O'Reilly.
Sir John Hay.	General Peel.

THE RIGHT HON. WILLIAM MONSELL, IN THE CHAIR.

Sir WILLIAM GEORGE ARMSTRONG, C.B., F.R.S., called in again; and further Examined.

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4923. General *Peel.*] ON the 16th November 1858, the Committee on Rifled Cannon reported as follows, "They have now the honour to recommend the immediate introduction of guns rifled on Mr. Armstrong's principle for special service in the field"?—Yes.

4924. But even previously to that an application had been received by the Under Secretary for War from the India House, dated the 28th of October 1858, requesting him to order a battery of your guns for the East India Company?—Yes.

4925. In consequence of the Report of that Committee, dated the 16th November 1858, on the 22d November 1858 an application was made to you by the Secretary of State for War, requesting to know in what time you could complete and deliver two field batteries of your rifled guns (12-pounders) with gun carriages and limbers ready for service?—Yes.

4926. And that application to you produced your letter, dated 24th of November 1858?—Yes.

4927. In which you say, "Before proceeding to reply to this inquiry, I must observe, in the first place, that, in order to supply guns upon this principle expeditiously and economically, a suitable plant must be provided for their manufacture"?—Yes.

4928. And you undertake in that letter as follows, "I am prepared to resign to the Government all exclusive rights I may possess in regard to this matter, and I am also ready to enter into a contract not to supply my guns or projectiles to any foreign power"?—Yes.

4929. And you also point out there that the outlay which was then contemplated would amount to about 12,000*l.*?—Yes.

4930. And you call upon the Government to give a guarantee that the Company to which you then belonged should not be losers by the erection of the building and machinery?—Yes.

4931. Did you then receive a reply which is No. 3 of these letters, "If the Government should hereafter cease to give remunerative employment for such buildings and machinery, they shall make such compensation to Mr. Armstrong, or the parties advancing the capital for the same, as, in the opinion of the Attorney General for the time being, shall be fair and reasonable under all the circumstances of the case"?—Yes.

4932. That produced your letter (No. 4) which is without date, but which must have been in December 1858?—It is December; that appears from the first sentence.

4933. In which you say, "Understanding that the Government is prepared to give the guarantee proposed in my letter of the 24th ultimo, I have directed the buildings and machinery referred to in that letter to be completed without delay"?—Yes.

4934. You then go on "With respect to the number of guns which I should be enabled to supply during the ensuing year, it must first be determined what nature of ordnance will be required, and in the absence of any decision upon that point, I will state my own views upon the subject." And then you state your views, and you recommend the guns mentioned in that letter to be supplied, amongst which are 10 first-class guns for ships and fortresses (100-pounders) and 10 guns (50-pounders) for siege purposes?—Yes.

4935. That letter was forwarded by me to Lord Derby, and Lord Derby in his answer suggested "that our first order should be confined chiefly, if not exclusively, to that class of guns, say 32-pounders, of which we have had sufficient proof, and that we should defer any orders for heavier guns till they have been rather more tested"?—Yes.

4936. The contents of that letter were communicated to you, in consequence of which you alter your proposal with regard to the guns in the following way: "Assuming that 200 guns upon my principle are to be supplied in the course of the ensuing year, and that none of them are materially to exceed in size those which have already been proved, I should propose the following apportionment in substitution of that which I have already suggested"?—Yes.

4937. And then you propose that there should be manufactured 200 guns, and alter the apportionment of the sizes?—The heavy guns are excluded.

4938. At page 245 in the same Report, on the 11th January, there are 90 12-pounders ordered. On the 24th January there are 20 25-pounders ordered, and on the 24th January there are 70 40-pounders ordered, making 180 guns, all for the land service, ordered in January 1859?—Yes.

4939. Now in the first application which was made to you, we, of course, were dealing with you as we should deal with any other manufacturer?—Yes.

4940. Now, were the prices which you mentioned

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tioned, prices at which you would have been prepared to enter into a contract, provided no guarantee had been given to you?—They imply a guarantee, I think.

4941. Therefore, if no guarantee had been given, and the Government had called upon you for a contract for that number of guns, should you have added the price of the plant to the amount of those provisional prices?—A considerable portion of it, at any rate.

4942. That would have made the 75,000 *l.*, for which you offer on the 23d of December 1858 to manufacture 200 guns, a much larger sum?—Yes.

4943. Were not the first applications that were made to you, made direct to you, you not being in the service of the Government, and being merely treated by the Government as any other manufacturer would have been treated. You were a member at that time of the Elswick Engine Works, from which the guns which you had submitted for experiments had been supplied to the Government; was not that so?—Yes.

4944. I believe that the actual cost of the 12-pounder which was experimented on at Woolwich was 250 *l.*?—I think it was at least that; according to my recollection, the first cost was more than that.

4945. Colonel *Dunne.*] The first gun was 387 *l.*, was it not?—I think something of the kind.

4946. And in another place, it is called 424 *l.*?—That would be probably including the carriage. I am pretty sure that the original cost of those guns was about 350 *l.*

4947. General *Peel.*] Then the price assumed here of 250 *l.* for each gun, included the guarantee?—Yes.

4948. And if no guarantee had been given, the price would have been much higher?—Yes, certainly.

4949. Do you recollect the date of your appointment into the service?—I think it was in February 1859; the memorandum defining my duties is dated the 23d February 1859.

4950. And up to that time, you were still a partner in the Elswick Engine Works?—Yes.

4951. In letter No. 9, at page 252, you state this: "I find that the outlay which will be necessary to provide buildings, machinery, and premises adequate to the magnitude of the orders already received for guns upon my principle, is likely to reach the sum of 35,000 *l.*" That is to say, the order received for the 180 guns?—Yes.

4952. This is on the 31st January 1859?—Yes.

4953. Do you know the absolute price that was charged for those 180 guns?—I think it was 170 *l.* for the 12-pounders.

4954. Will you take that vote in your hand, and kindly state to the Committee, how much money was taken in the Estimates for the Army, for the financial year 1859–60, for Armstrong guns?—£. 73,000.

4955. I had provided in the next financial year 73,000 *l.* for the 180 guns which I had ordered from you at the provisional prices stated in your letter of the 23d December 1858?—Yes, I presume that is so.

4956. I find on reference to page 245, that, instead of their costing 73,000 *l.*, they absolutely cost 42,650 *l.*?—Yes.

4957. If there had been no guarantee given at all, the prices would have been even higher than 75,000 *l.*, for you would have included in the price a great portion of the price of plant, and it would therefore appear that the amount of the first guarantee, 35,000 *l.*, was saved upon that first order for 180 guns?—Yes, I think that is quite clear. I think it is fair to assume that if you had insisted upon a contract, and had not given a guarantee, the 73,000 *l.* would have been 100,000 *l.*, which would have made a difference of nearly 60,000 *l.*

4958. Do you remember what was the time at which you gave up being a member of the Elswick Engine Company, and at which the guarantees and the orders of the Government were transferred to the new company?—I never gave up being a member of the engine company, but I withdrew from—in fact, I can hardly say I was ever identified with—the ordnance company; it was merely that the buildings and so forth were intended as an extension of the engine works; but the moment it became apparent that I was going to take an official position, it was arranged that the new works should be detached and carried on by a separate company; that would be very shortly before my appointment; in fact, very soon after the extensions had been decided on.

4959. The Admiralty demanded a gun to be made of a much larger calibre by way of experiment, did they not?—Yes, a 70-pounder, I think.

4960. And you addressed a letter to the Secretary of State for War on the 23d of February 1859, in which you said, "I beg to remind you that a 70-pounder gun upon my principle is now in progress for the purpose of experiment, and that a gun specially adapted for boat service is also in hand with a similar view. There can scarcely be a doubt that these guns will be successful, in which case a demand for them will at once arise;" and you called upon the Government for a further guarantee of 15,000 *l.*—Yes.

4961. And on the 25th February 1859, I find this Minute of my own, "I have obtained the sanction of Lord Derby to granting the additional guarantee of 15,000 *l.* Let it be given and communicated to Sir William Armstrong"?—Yes.

4962. Therefore up to that time the guarantee amounted to 50,000 *l.*?—Yes.

4963. Now would it have been possible at that time, or at any time within that period, to have manufactured those guns at Woolwich?—No, certainly not, nor elsewhere; that is to say, up to the 25th of February 1859.

4964. *Chairman.*] Even though the plant at Woolwich had been increased?—But it had not been increased.

4965. But supposing that the money had been spent at Woolwich which had been spent at Elswick, would it have been possible?—But it had been spent at Elswick. The Gun Factory at Woolwich was merely a gun foundry at that time, without any plant for making Armstrong guns.

4966. General *Peel.*] But supposing that the Government had taken your gun, and had tried to make it themselves at Woolwich without any question of patent, do you think it would have been possible for any artillery officers, speaking generally, or for the artillery officer in particular at the head of that department, although "an exceedingly able and excellent officer" (Colonel Wilmot), to manufacture that gun at Woolwich?—The

—The means did not exist at Woolwich till August 1859 for making those guns.

4967. But even supposing the means had existed, would it have been possible without your assistance, to manufacture the guns at Woolwich?—No, I think it would not have been possible without my assistance at that time, nor would it, I think, have been possible to obtain the guns from any source whatever, excepting Elswick at that period.

4968. We have now got to a guarantee of 50,000*l.*; but there was a further guarantee of 10,000*l.* at the time you considered it necessary to begin manufacturing projectiles for the guns already ordered?—Yes.

4969. I gave a further guarantee for 10,000*l.* on the part of the Government for the manufacture of projectiles?—Yes.

4970. And Lord Herbert afterwards gave a further guarantee of 25,000*l.* for the same purpose, which constituted a guarantee of 85,000*l.* to the Elswick Ordnance Company?—Yes.

4971. Although provision had only been made in the estimates of 1859–60 for the manufacture of those guns for which an actual order had been given; namely, the 180 guns ordered in January, it was very evident that if the Armstrong guns (and particularly the larger calibres) were introduced into the Navy, a much heavier expenditure would be required hereafter?—Yes, certainly.

4972. *Chairman.*] But after the time that your services were secured to the Government, what sum of money do you consider it would have been necessary to expend at Woolwich, in order to make the Royal Gun Factory there, capable of producing all the guns that were produced at Woolwich and at Elswick?—Speaking roughly, I think it would have been necessary to increase the establishment at Woolwich, to the extent of Woolwich and Elswick combined.

4973. How much would that have cost?—The machinery and buildings at Elswick cost something like 180,000*l.* or 170,000*l.*

4974. Would it have been necessary to build as much at Woolwich as has been built at Elswick?—Yes, I think so, to produce the same number of guns at the outset.

4975. How does that agree with Mr. Anderson's statement, that he could have produced, with the machinery he had at his command, a third more guns than he did produce?—I do not recollect the particulars of his statement, but I should imagine that that would have reference to what he could have produced after the place was fully organised, and in full operation.

4976. Mr. Anderson was asked, at Question 1421, last year, "What number of guns, on the average, could you manufacture in your department?" to which he replied, "Taking the 110-pounders, the 40-pounders, the 25-pounders, the 12-pounders, and the 9-pounders, I think we should be able to manufacture 30 per week. How many did you manufacture last year per week? About 20 a week"?—Yes; but that speaks of the time when he gave his evidence.

4977. That having been after the money was expended on the Royal Gun Factory, for the purpose of making it capable of producing your guns, Mr. Anderson states, that without any additional expenditure, the Royal Gun Factory could have produced 30 guns a week, instead of 20?—For the first two years, both Woolwich and Elswick were working at extremity; I do not think you could possibly have got more from them during the first two years; towards the close of that time, as the orders diminished, and as the producing power at Woolwich had become amplified, no doubt Woolwich could have undertaken larger orders.

4978. What was the largest number manufactured in one year at Woolwich?—I do not recollect.

4979. In what year was the great demand?—The largest production would be in 1860 or 1861.

4980. It appears that there were only 20 guns a week manufactured at Woolwich?—Very possibly.

4981. And still Mr. Anderson states, that 30, even without increasing the machinery, could have been manufactured there?—I do not know that it could, all through the year; towards the close of the year, perhaps, it might; but for by far the greater part of that period, both the factories had been working at extremity; there is no question about that.

4982. You could not state, with any accuracy, what sum of money it would have been necessary to spend at Woolwich, to make it capable, even during that time, of producing the number of guns that were produced at Woolwich and Elswick?—I do not think a less expenditure at Woolwich than was actually made at Elswick would have sufficed for that result.

4983. About 180,000*l.*—Yes.

4984. And in the Royal Laboratory would a large expenditure also have been necessary?—I cannot give an opinion.

4985. Colonel Boxer stated distinctly that he considered he could have manufactured the whole?—I do not know the capabilities of the Royal Laboratory.

4986. General *Peel.*] When orders were given for a number of guns, was there any limit of time within which they were to be produced?—Yes.

4987. Were they all completed within the course of the financial year for which they were ordered?—I think so.

4988. You think you were able, with the two manufactories, to complete the orders within the year?—We were very hard run; I think it is very likely that the orders ran over a little into the following year.

4989. Both the factories at Woolwich and Elswick were working up to their full power?—No question about it; they were working at high pressure.

4990. Neither Woolwich alone nor Elswick alone could have done it?—Not without a greater expenditure.

4991. *Chairman.*] Does that apply to projectiles?—I do not know the capabilities of the Royal Laboratory to produce projectiles.

4992. Mr. *Baring.*] The test of that would be that during those years 1860–61, and 1861–62, the War Office were almost daily pressed upon by the Admiralty to deliver the 40-pounder guns which were demanded, and which could not be supplied as fast as the Navy wanted them?—Yes.

4993. General *Peel.*] But with regard to projectiles, they were not manufactured at all at Woolwich for a very lengthened period?—No.

4994. Why was that?—I think the reason was that Colonel Boxer objected to any interference on my part.

4995. When you handed over to the Government the patent for the fuzes, I think you reserved the right to superintend the manufacture

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of the fuzes?—I pointed out the expediency of my retaining for a time the manufacture of the fuzes till they had been brought to maturity; but I stated that I did not at all contemplate the projectiles being made elsewhere than at Woolwich.

4996. In fact, it was intended originally to make the projectiles at Woolwich?—Yes.

4997. *Chairman.*] You say that there was a very great pressure for the 40-pounders; do you know how many were issued before the 1st of March 1862; it is stated here at 192?—I think it is very likely. I should like here to correct a statement which I made just now, with regard to the amount which it would have been necessary to expend at Woolwich, in order to place the Gun Factory in the same position as Elswick and the Gun Factory combined. I spoke of it as being the whole capital expended at Elswick; it did not occur to me at the time that that included the expenditure on buildings and machinery for the manufacture of ammunition; it would therefore not be the whole; I should say, speaking roughly, that it would be about 120,000 *l.*

4998. Colonel *Dunne.*] What would be the whole expenditure necessary, then, to make those guns, adding what has been and what would be?—I think the sum expended on plant at Woolwich has been, deducting depreciation, 224,000 *l.*, and you would have had to add probably 120,000 *l.* to have enabled the Royal Gun Factory to have done the whole work.

4999. And does that include the value of the old foundry for casting guns?—Yes.

5000. The entire value of it?—Yes, the entire value, subject to depreciation; the actual expenditure would be a good deal more.

5001. That is the cost of the foundry?—The cost of the foundry, with the subsequent alterations and additions, amounted, with an abatement of 5 and 10 per cent. per annum for depreciation, to 224,000 *l.* in the year 1861-62.

5002. Major *O'Reilly.*] I find it stated at No. 4631 of the last day's evidence, that the following passage occurs in a letter of yours to Captain Blakeley, dated the 9th of April 1859: "I must inform you that the guns which are being made under my direction, have no interior lining of steel, and are not in any way affected by your patent." On the other hand, in answer to questions 3487, 3488, and 3489, with regard to what was the system of construction of guns obtained from you by the country, you stated this: "I referred to the coiled system; you referred both to the barrel and the external hoops? It is applicable to the barrel and to the hoops.—Then what do you mean by the coil system as applicable to the barrels and the hoops? The gun with the barrel of steel, as exemplified in my first gun"?—Yes.

5003. Will you be good enough to explain what appears to be the discrepancy of those two statements?—I do not see any discrepancy; my recollection is that Captain Blakeley, at that time, was threatening me with an action for a supposed infringement of his patent, and I presume he had alleged that I was making guns with a steel barrel. I merely put him right on that point; but if I had been doing so, I do not consider that it would have been any infringement of his patent. I cannot understand what he claims; all I can gather is that he is an advocate of the system of hooping guns, and every gun embraced within the principle of a hooped gun, he says is the same as his gun; he says that mine is the same as his gun, and that the French gun is the same as his gun, and therefore it would follow that my gun and the French gun are the same, which is perfectly absurd.

5004. Then, in speaking in the answer to which I have referred you, of "the gun with the barrel of steel," you did not intend to rely on that as the difference between the two guns?—I merely stated it as the fact. We could not get steel suitable for the barrels; the steel was not to be had; I would have used it without hesitation if I could have got it. I am quite sure that no patent Captain Blakeley held would have been adequate to prevent my using steel.

5005. I find in the specification of Captain Blakeley's patent, dated the 27th February 1855, as given in his evidence, the following words: "The improvements relate, first, to a method of forming guns with an internal tube or cylinder of cast-iron or steel, enclosed in a case of wrought-iron or steel. I sometimes form the outer surface of the inner tube somewhat conical, the greatest diameter being just in the front of the trunnions, and tapering both ways, and apply the outer casing in the form of collars or rings driven thereon; and in some cases I apply two or more layers of such rings, according to the strength sought to be obtained, the trunnions being of one piece with one of the rings. The outer casing may, however, be applied in the form of collars or rings, heated and shrunk upon the cylinder or tube; but I do not claim as my invention the method of forming guns or cannon by the application of collars or rings heated and shrunk upon a cylindrical inner tube, save and except when the internal diameters of such collars or rings are, previously to being heated, so much smaller than the external diameter of the inner tube on which they are shrunk; that, after being cooled, the outer casing formed by the rings or collars is in a state of tension or permanent strain;" but in your report of the 14th July 1855, two months later than that, you state this: "It is found that steel was more subject to defects of welding than iron; but being a harder substance, and therefore more fitted to form the surface of the bore, I determined to apply it as an internal lining, and to obtain the necessary strength by encircling it with twisted cylinders of wrought iron, tightly contracted upon the steel core by the usual process of cooling after previous expansion by heat"?—Yes.

5006. And in reply to question 3543, you say, in reference to this, "I have referred to the report which I sent in in 1855, and which I have already mentioned in evidence before this Committee as the definition of the points of which my plan consists. That report, taken in conjunction with the drawings which I have produced, perfectly defines what my system of construction was then and is now"?—Yes.

5007. Then am I right in inferring, that your system of construction "as it was then and is now," involved an internal lining of steel, with twisted cylinders of wrought-iron tightly contracted?—When the steel is to be obtained. I do not think I can possibly be more explicit than I have been already; I have stated that if the steel can be obtained, it is unquestionably the best material, and it is the proper mode of construction; but if steel cannot be obtained, the alternative is to use coils for the barrels.

5008. Then

5008. Then will you kindly point out what, if any, you consider to be the difference between the mode of construction described in your report of the 14th July 1855, and that described in Captain Blakeley's specification, dated the 27th of February in the same year?—You must take Captain Blakeley's specification in combination with his disclaimer; he disclaims a great part of his specification; he disclaims the use of hoops unless they are put on by shrinkage. Now, can any human being conceive the application of hoops put on without shrinkage; what is the meaning of it? Put on hoops loose! Shrinkage means nothing in the world but stretch; every gun ever made on that principle has had hoops applied, of smaller diameter than the barrel; you cannot do otherwise; the principle is as old as the hills.

5009. But Captain Blakeley does not disclaim the use of the steel barrel, does he?—I think he does; but nobody can patent the use of a steel barrel; steel is available as a material to anybody that chooses to use it, if it can be obtained; but the whole question is whether it can be obtained.

5010. In your evidence (Q. 3266) as to what you think to be the advantages gained by the country by the expenditure on improved ordnance since 1848, you say you think "it has gained a system of construction for guns;" and in referring to that, General Peel asks you this question at 3542: "I suppose that the peculiarity of construction is that which is referred to in page 2 of Appendix No. 48: 'The mode of manufacture ultimately adopted, and which forms an essential peculiarity of these guns, constitutes the subject of a provisional specification, dated the 15th of November 1858, and which has now four months to run.' That refers to the patent taken out and which you handed over to the Government"; And to that question of the honourable and gallant Member your answer is, "Yes." Am I right in concluding that the result in "your words" of the expenditure which has been incurred since 1858, is involved in the patent which was taken out, and which was there referred to?—No; I never attached any value to the patent; what the Government has obtained is the realisation of those results, not the mere idea, but the working out of that idea.

5011. You do not consider that the value received for the expenditure was the possession of the patent?—I never cared for the patent; I never contemplated a patent, but the Government chose to have it.

5012. You do not consider that the patent was the value for the expenditure incurred?—No, I do not.

5013. Mr. *Baring.*] When you were in connexion with the War Office, were you consulted with regard to the prices paid to the Elswick Ordnance Company for guns or projectiles?—No.

5014. Were you consulted with regard to the distribution of orders either for guns or projectiles between the Elswick Ordnance Company and the Woolwich Factories?—No.

5015. *Chairman.*] Do you remember when you first met Captain Blakeley?—I do not know; I cannot give that precisely.

5016. Was it before 1856, do you know?—I really cannot say.

5017. Colonel *Dunne.*] Was it at Harwich?—No; I never met him there.

5018. *Chairman.*] Was it at Landguard?—No; I think it was at Elswick.

Jovis, 2° die Julii, 1863.

MEMBERS PRESENT:

Mr. Baring.	Mr. Laird.
Mr. Beecroft.	Mr. Monsell.
Mr. Dodson.	General Peel.
Colonel Dunne.	Sir Morton Peto.
Marquis of Hartington.	Sir Frederic Smith.
Sir John Hay.	Mr. Vivian.
Captain Jervis.	

THE RIGHT HON. WILLIAM MONSELL, IN THE CHAIR.

EARL DE GREY AND RIPON (attending by permission of the House of Lords); Examined

Earl *De Grey and Ripon.* 2 July 1863.

5019. *Chairman.*] YOUR Lordship fills the position of Secretary of State for War?—Yes.

5020. For some time before that, you were Under Secretary of State for War?—Yes.

5021. Can you state how long you were Under Secretary of State for War?—I became Under Secretary of State for War when the present Government was formed, at the end of June 1859; and I remained Under Secretary of State for War until January 1861, when, in consequence of the late Lord Herbert being made a Peer, I ceased to be connected with the War Office and went to the India Office; I became Under Secretary of State for War again at the end of July in that year, 1861, when Sir George Cornewall Lewis became Secretary of State; I remained Under Secretary until, on Sir George Cornewall Lewis's death, I accepted the office of Secretary of State.

5022. Mr. *Laird.*] It has been stated that your Lordship would be willing to give an explanation of the compensation paid to the Elswick Ordnance Company?—Yes, certainly.

5023. I am desirous to ascertain the basis on which it was settled; whether it is all contained in the Appendices, and also whether the plant now belongs to the Government or to the Elswick Ordnance Company?—The whole of the information necessary for arriving at an accurate understanding of the arrangements finally made, is contained in the papers laid before the Committee. The arrangement with regard to the plant is this—that the portion of the plant contained in the schedules recited in the final agreement, and given in these papers, may be taken by the Government at a certain price, and that the rest of the plant, not alluded to in those schedules, will remain the property of the Elswick Ordnance Company.

5024. The Government do not take the whole of the plant?—No.

5025. Is the settlement based on a guarantee applying to buildings as well as plant?—The settlement is, of course, based on the original agreement; the Government are bound by the original agreement made between General Peel and the Elswick Ordnance Company, and the arrangement is necessarily founded on that agreement.

5026. The first agreement was an agreement to guarantee them against loss for undertaking the execution of certain works for the Government; but the charges made by the Elswick Ordnance Company embraced (according to statements made by them) a large amount for depreciation of plant in the estimated cost of the guns and projectiles sent in?—No doubt the Elswick Ordnance Company, in the price which they charged to the Government for the guns and projectiles made by them, did include a charge for depreciation; and it was upon that ground that the valuer of the Government, the late Mr. Fenton, contested the sum which was claimed on behalf of the Elswick Ordnance Company by their valuer, Mr. Harrison, under the head of depreciation. That sum, as appears from the papers before the Committee, amounted to 20,009 *l.*, and that sum has not been paid in that shape by the Government.

5027. Was that the total amount of depreciation written off on the work supplied to the Government?—£. 20,009 is the value of the depreciation, as estimated by the valuers appointed by the two parties.

5028. But in making out their charges against the Government, it appears, from their statement last year, that they charged 10 per cent. on work done for depreciation?—Yes.

5029. So that if the amount of the work done is nearly 1,000,000 *l.*, and that 10 per cent. was written off, that would give 100,000 *l.* depreciation?—The valuers had all those facts before them. The 20,009 *l.*, which Mr. Harrison considered the Elswick Ordnance Company were entitled to receive, over and above what they had received for depreciation in the prices of articles, the Government valuer considered them not entitled to receive; thereupon, in the course of the negotiations, before the final settlement was made, I took a legal opinion in respect to the claim of the Company for that sum of 20,000 *l.* for depreciation. The case submitted to counsel stated the facts alluded to by the honourable member, namely, that a sum had been charged to the Government in the prices of the different articles supplied by the Elswick Company under the head of depreciation, and that on that ground the department was inclined to contest the propriety of paying anything further under that head to the Company. The advice given was that neither the view of the Company nor the view of the Government was, in the opinion of counsel, strictly

strictly to be sustained; that no doubt they had received a certain amount for depreciation, but that, on the other hand, they had kept up their plant in an efficient state for the work of the Government during the whole time that they had been employed by the Government, and had also added new plant, supplementing it, where it might be necessary, by improved plant or new machines; and that, under those circumstances, the Government were not entitled to refuse to entertain all claim on their part on the score of depreciation. It was in accordance with that opinion that I proceeded to negotiate the final agreement.

5030. All those points were considered before the settlement was come to?—Fully.

5031. It was considered by the Government that they were entitled to claim from the Elswick Ordnance Company the amount for depreciation that has been charged to the Government in the various accounts rendered?—It was considered that we were entitled to take into our consideration the fact that sums had been paid in the prices of articles for depreciation, and that matter we did accordingly take into consideration; but we were advised by our counsel that, under the original agreement, we could not legally refuse to entertain all claim for depreciation from the Company, the amount being a question for negotiation. The basis upon which the agreement was ultimately made was this: the award (which you will find in Appendix 48), dated 30th March 1863, sent in by the two legally appointed valuers under the deed signed by General Peel contains this passage: "We agree that the amount due to the Elswick Ordnance Company is 85,544 *l.* 4 *s.*, on the assumption that the Government are not entitled to claim the deduction of the sum of 20,009 *l.* on account of previous depreciation of the machinery, this question being left for further consideration; Mr. Fenton, on behalf of the Government, claiming that such sum ought to be deducted, and the amount thereby reduced to 65,535 *l.* 4 *s.*, and Mr. Harrison, on behalf of the Elswick Ordnance Company, claiming that no such deduction ought to be made." That award, made on the 30th of March, was immediately transmitted to the War Department; and on being submitted to Sir George Lewis, he ordered, as I learn from the papers, that steps should be taken to pay the sum of 65,534 *l.* 4 *s.* to the Elswick Ordnance Company, that being the sum about which the valuers had no dispute. With regard to the further sum of 20,009 *l.*, that matter was left open for negotiation. I will not enter into the details of those negotiations, but the result of those negotiations (which were commenced when Sir George Lewis was Secretary, and were concluded after I had accepted office) was, that instead of paying 20,009 *l.* and getting nothing in return, which would have been the result if this award had been carried out as proposed by Mr. Harrison, we paid to the Elswick Ordnance Company the sum of 19,464 *l.* 16 *s.* (making a total, with the 65,000 *l.* odd, of 85,000 *l.*) and received from the Company stores and plant.

5032. Then, the amount paid them has been 85,000 *l.* altogether, you getting a portion of the machinery and plant?—Yes; and stores.

5033. But not all the gun machinery?—The schedules of what we received were arranged between the Company and the officers of the department. We have the right to take all the machinery included in those schedules, which would have been of very little value to them, but would be of great use to us, as being special machinery intended for the manufacture of Armstrong guns.

5034. Mr. *Beecroft.*] At a valuation?—Yes. We have taken those stores, detailed in Schedule No. 11 (gun-iron, pig-iron, furnished shot and shell, guns, packing-boxes, and other matters of stores entirely available for our purposes) at the cost-price set out here; that amounts to 11,771 *l.* 10 *s.*

5035. *Chairman.*] That is the value of the stores which you have taken?—Yes. We are further entitled to take, under the agreement, plant, the depreciated value of which (which means the value to sell in the market to people not manufacturing Armstrong guns) is 2,933 *l.* 12 *s.*; the invoiced value of the plant we are entitled to take (that is to say, the original cost of that plant) was 26,211 *l.* 11 *s.* 10 *d.* That plant, of course, would not be worth to us, or to anybody, its original cost; but it would be worth to us, if we chose to take it, a good deal more than its value in the market, because it consists of special machines for the manufacture of Armstrong guns. I am, consequently, of opinion that we have, in stores and in plant, the full and entire value, and I think, to us, over the value of the 19,464 *l.* 16 *s.*,, which we have paid over and above the sum of 65,000 *l.*, which was awarded without dispute by the valuers.

5036. Mr. Clode stated, last year, he should imagine that the compensation would be limited to all the special plant which was applicable to no other purposes than this manufacture; has your Lordship got all that special plant?—We have got as much of the plant as we chose to take; and we have got, instead of a portion of it, those stores which we considered to be of more value.

5037. Mr. Clode's evidence was very distinct indeed, that he considered that the Government would have to pay nothing more than the value of the special plant which was applicable to no other purpose?—Quite so; but I must remind the Committee that that is only Mr. Clode's opinion. I may freely say that this was not, perhaps, the bargain which I should have made, if I had not had an agreement which bound me on the one hand, and if I had not had the opinion of the valuers on the other. I can give no opinion of my own with regard to the value of those stores, or what is the compensation legally due under those documents. The question on the one hand is a question of law, and on the other hand a question of valuation by competent persons; when I entered on this negotiation, I was bound by the acts of the valuers.

5038. Your Lordship acted under legal advice?—Certainly. I did not expect that the sum of 65,000 *l.* odd would have been awarded by the valuers; but they were legally appointed, one by Government, and the other by the Elswick Ordnance Company, under a legal deed, and, of course, both parties were bound by the acts of their agents so appointed.

5039. The result of the whole arrangement with the Elswick Ordnance Company is, that we have paid a sum of money very much larger than we should have paid if the articles had been made at Woolwich, and, in addition, that we have had to pay 85,000 *l.*, for which we have value about 19,000 *l.*?—My own impression is that we have value for more than 19,000 *l.* Perhaps I should mention to the Committee that under the understanding with the Elswick Ordnance Company it is open to us, if there is any

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schedule that we do not want to take when examined by our own officers, to leave those articles and reduce the amount to be paid to the Company by the depreciated value of the plant so left.

5040. Mr. *Laird.*] Have you the power to take all that which is specially applicable to making those Armstrong guns?—That is the arrangement; that is to say, we have the power to take all that is put down in those schedules; and those schedules were drawn up on the principle of including the special plant.

5041. Referring to page 18, with reference to the stores, you will see there is a "cost" column and a "realisable value" column: did I understand your Lordship to say that those stores were taken at their cost, or at their realisable value?—Those stores were taken at the cost-price; the realisable value is the value to sell in the market; they are taken at the cost-price because they are things actually applicable, immediately, by us to the manufacture or use of the guns, such as gun-iron, furnished shot and shell, pig-iron, and so on. The stores are taken at cost-price; the machinery is taken at the depreciated value; and taking the machinery in that way would leave a balance upon the 19,000*l.* of 4,759*l.* That, in my opinion, is less than the difference between the real value to us of the plant so taken and its depreciated value to sell in the market.

5042. Sir *John Hay.*] In reply to the honourable Member for Birkenhead, I think you stated just now, with regard to your opinion as to the Elswick Contract, that if you had not been bound by certain legal documents, the arrangement was not one which you would have considered desirable to make; I should therefore like to know whether you think that by the arrangements which have been made with the Elswick Ordnance Company generally, the country may be considered to have lost to the extent of 65,000*l.*?—Certainly not. I did not intend to say that, if there had been no agreement, I could certainly have made a better arrangement. I merely said that I was bound by the agreement, and that I was not free to make any arrangement which was not consistent with the agreement and the award of the valuers; and I said that the amount of that award was larger than I anticipated. I expected, and it was the general expectation of the War Office no doubt, that the award would be less in amount; but the arbitrators being appointed under a legal document, we were bound to accept their award.

5043. Do you then think, that by the original agreement great disadvantage has resulted to the public?—No; I think that, in looking at that question, you must remember the circumstances under which the original agreement was made; it must be borne in mind, that at that time this manufacture was entirely new. My opinion is this with regard to the original agreement, that the Armstrong gun having been adopted by the late Government, upon the recommendation of their scientific and professional advisers, as the rifled gun of the service, at a time when a speedy supply of rifled guns was very necessary, it was the duty of the Secretary of State at the time to make the best arrangements that he could for the production of that gun as speedily as possible. The manufacture was entirely new; the invention was Sir William Armstrong's, and the arrangement with Sir William Armstrong had obtained his services to carry out and continue to superintend his invention; and General Peel appears to have thought it was desirable, with a view to supply these guns as soon as possible, that, in addition to the resources at Woolwich, a separate company should be set up for the purpose of the special manufacture of that gun: that company was accordingly established under that agreement. I do not say that, if I had now to make that agreement, looking back upon it with the light of all that has passed since, I am prepared to pledge myself that I should make an agreement of that description. But looking to the circumstances in which General Peel was placed at the time, and to the necessity of getting the speediest possible supply of those guns, I have no doubt it was, in General Peel's opinion, the best arrangement that he could make for the public service; and I am not prepared to impugn that opinion, under the circumstances in which he was placed at that moment.

5044. Captain *Jervis.*] The sum of money which was guaranteed to the Elswick Ordnance Company by General Peel was 50,000*l.*, was it not?—It was 60,000*l.*

5045. It was afterwards increased by Lord Herbert?—It was first increased by General Peel 10,000*l.*

5046. And then further increased by Lord Herbert?—Yes.

5047. When the gun was first introduced, it was entirely as a field-gun; and in Lord Herbert's time the Armstrong principle was adopted by the Government for rifled guns of large calibre?—Yes, it was in Lord Herbert's time. I am not prepared, from recollection, to contest that it was only adopted as a field-gun; I think that the Armstrong principle was adopted by General Peel as the principle on which rifled guns were to be manufactured by the Government, but the only guns introduced at that time were field-guns.

5048. It was Lord Herbert who directed the experiments to be carried out with Mr. Whitworth's guns, and also very large experiments, to see whether cast-iron guns could be made available for the service?—Yes.

5049. And, as the result of his inquiries, did he keep to the Armstrong principle for guns of larger calibre?—Yes.

5050. And there was very heavy pressure for guns for the Navy as well as for fortresses put on the War Office, was there not?—Yes.

5051. Both the factories were kept at full work; and, in order to have the whole of the work done at Woolwich, that establishment would have been required to be very much extended?—I think so.

5052. Evidence was given by Mr. Anderson, before the Military Organization Committee of 1860, that the alterations required in the Gun Factory, to make it available for the production of Armstrong guns, cost upwards of 200,000*l.*; it must have been a very great question for the Government to decide whether they would spend that sum of money for that purpose, or whether, by the guarantee, they could get the Elswick Works as well?—Yes, quite so; when Lord Herbert became Secretary of State for War, the agreement with the Elswick Ordnance Company had been entered into, and that company was in existence.

5053. Captain *Jervis.*] We have a paper before us, drawn up by the Director of Ordnance, dated the 19th March 1862, from which it appears that the whole of these questions had been duly considered by

by the War Department previously to this Committee being appointed?—The whole question was under the consideration of the late Secretary of State for War when the Committee was appointed, and it occupied a large amount of his attention during the last year; for during the last year our demand for guns became less, and our means, consequently, of employing the Elswick Ordnance Factory became diminished; and the period was evidently approaching when it would be necessary to wind up our engagement with the Elswick Company, because we had not the means of profitably employing them.

5054. Colonel *Dunne.*] At the time that General Peel adopted those guns, was there any means or possibility of making the guns for a considerable time in the Royal Gun Factory?—No; it would have been necessary to buy machinery, and set up new plant.

5055. It was nearly a year before they turned out any guns in the Royal Gun Factory?—Yes; there was a manufactory (which was then under Mr. Anderson) by the side of the Royal Gun Factory in which Armstrong guns were being prepared at the time that the present Government came into office.

5056. But they did not turn out any gun from the Royal Gun Factory for a year after they had been made in the Elswick Ordnance Works?—I think not.

5057. At the time that General Peel required the guns, there were facilities for making those guns in the Elswick Works?—Certainly.

5058. But he could not have obtained those guns until plant and machinery had been erected at Woolwich?—That is my opinion; I have no personal knowledge of the fact.

5059. Then the making of the larger guns was entirely ordered by Lord Herbert?—The larger natures of guns were first ordered by Lord Herbert.

5060. Therefore, I think that General Peel is by no means accountable for those experiments, whether right or wrong, which were subsequently made on those larger guns?—Certainly not; I have not stated so.

5061. General *Peel.*] When first the agreement was entered into, and the guarantee given to the Elswick Ordnance Company, would there have been power on the part of the Government to manufacture these guns for the service?—They would have had to set up new plant, and make extensive alterations and additions at Woolwich.

5062. But independently of that consideration, the only courses open to the Government were, either to order the guns they required at ordinary contract prices, or to give such a guarantee as was actually given, the amount of which, as appears by the papers before us, was saved upon the first order given for guns?—I do not know whether the honourable and gallant general considers that the guarantee given by the agreement with the Elswick Ordnance Company was a part of the general arrangement by which the patent of Sir William Armstrong and his services also to the Government were obtained: it is a question on which I can give no opinion; it is a matter within the knowledge of the honourable and gallant general himself.

5063. But I mean the original application to Sir William Armstrong, founded on the report of that Committee we have been referring to, was made to him before any services at all had been required from him to the Government; and we were dealing with him as we might have dealt with any other manufacturer who had produced a gun which had been approved of?—Yes, quite so; it is perfectly obvious, that until the Government entered into a special agreement with Sir William Armstrong, they stood in the same relation to him as to any ordinary inventor.

5064. I moved, did I not, for a supplemental estimate of 30,000 *l.*, in order to establish a manufactory at Woolwich for the purpose of regulating the prices, and coming to some conclusion with regard to the proper cost of the gun?—Yes, I think so. The prices at Woolwich, I find, were much higher than they are now; and it is natural to conclude that those prices were kept down by comparison with the prices at Elswick.

5065. The gun had been only adopted by Lord Derby's Government on the recommendation of that Committee for special service in the field, Lord Derby's Government having come to no conclusion with regard to the introduction of that gun as a naval gun?—Yes; I spoke in my previous answer of its being adopted into the service in a general sense.

5066. With regard to its introduction into the service as a naval gun, that depended upon the experiments afterwards carried out upon requisitions from the Admiralty to the War Office?—Yes, certainly; we receive our requisitions from the Admiralty with regard to guns for the Navy, and we have only to carry them out.

5067. Colonel *Dunne.*] Is your Lordship aware what the old cast-iron gun-foundry cost to the country?—No.

5068. General *Peel.*] Unless that patent of Sir William Armstrong had been placed in the hands of the Government in the first instance, the Government would not have been able to manufacture the gun originally, would they?—No.

5069. And that patent remains in your hands?—Certainly.

5070. And you can prevent anybody else manufacturing those guns?—Certainly.

5071. *Chairman.*] Does your Lordship consider that you could prevent anyone from manufacturing Armstrong guns?—I consider that the Secretary of State is in the position of any other patentee; and whatever powers Sir William Armstrong would have possessed, if he had had the patent in his hands, are possessed by Government now that they have the patent.

5072. The Committee would like to know, whether your having that patent would preclude any private manufacturer from making Armstrong guns?—That is a question of law; the patent would prevent that being done which is in contravention of the patent.

5073. Sir *John Hay.*] But if it is a good patent, you could prevent Sir William Armstrong, or anybody else, manufacturing those Armstrong guns?—Yes.

5074. General *Peel.*] The Government could refuse anyone the power to manufacture those guns?—No doubt.

5075. Colonel *Dunne.*] Your Lordship thinks it unadvisable that that patent should be published?—Yes; Parliament has given the power to keep it concealed for the benefit of the public.

5076. General *Peel.*] When that Act was passed

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passed, great importance was attached to keeping the manufacture secret?—Yes.

5077. The Elswick Company were told not to let anyone enter the factory, or to see the guns manufactured, were they not?—There are special covenants for that purpose in the agreement with the Company.

5078. Mr. *Beecroft.*] Sir William Armstrong stated the other day that he attached no value to the patent, therefore, may I ask why you are disposed to refuse to let the patent be produced to the Committee?—I am disposed to think that it would be contrary to public policy, because that patent was intended to be kept concealed by the Government under the powers of that Act. It appears to me that if the patent were produced to the House of Commons, and thereby made public, the Act of Parliament would be perfectly valueless. Upon general grounds, I am of opinion that it would be contrary to the policy of Parliament and the statute.

5079. But your Lordship is aware, I presume, that there are some parties who dispute the validity of that patent?—I have heard so.

5080. Does the Act preclude the exhibition of the patent?—I think not; but it places in the hands of the Secretary of State for War the power of keeping the patent concealed; as you know in ordinary cases, the monopoly granted by a patent, is only given upon condition that the specification is made public; but in reference to patents of certain descriptions, Parliament has deviated from that policy, and that is the case here.

5081. It is at the discretion of the Secretary of State for War to produce the patent, is it not?—Certainly; and it is in the exercise of my discretion that I say I think it unadvisable on public grounds that the patent should be produced.

5082. *Chairman.*] With reference to the question when the Royal Gun Factory at Woolwich first began to produce Armstrong guns, I see in Captain Caffin's evidence, at Question 2480, of last year, that there were 115 12-pounder guns received, in 1859–60, from the Arsenal at Woolwich, therefore it is clear that at that time they had begun to manufacture Armstrong guns?—I should have thought that that was from the small factory, and not from what is strictly called the Royal Gun Factory.

5083. General *Peel.*] The guns were first manufactured at Woolwich in 1859, in small numbers, were they not?—Yes, in that small separate factory.

5084. In the factory established by that Vote to which I have referred your Lordship?—Yes, that is what I call the small factory.

5085. Therefore, it would have been in the power of Government, at any period, to put an end to the agreement with the Elswick Ordnance Company, by paying them the guarantee, and taking the plant into their own hands?—It would have been in the power of the Government, at any period, to put an end to the agreement with the Elswick Ordnance Company, by fulfilling the conditions of that agreement.

5086. Therefore, any portion of the 242,000 *l.*, which it was possible to save, might have been saved at any time by paying to the Elswick Ordnance Company the 85,000 *l.* which the Government were bound, under the agreement, to pay them?—The agreement might have been put an end to at any time, by paying what was due under the agreement, and any saving so effected might have been effected at any time; but I cannot say what the amount of the saving would have been.

5087. *Chairman.*] I suppose that both the guns and projectiles were covered by the guarantee?—Yes.

5088. Sir *John Hay.*] Is it within your Lordship's knowledge whether the Government, with both factories fully at work, were then able to obtain all the guns they required?—There was at one time great pressure; that pressure finally ceased, but at first we were working to the utmost of our strength at both factories.

5089. In the House of Commons, on the 15th of July 1859, the late Mr. Sidney Herbert is reported as follows: "He could assure the Right Honourable Gentleman that the Government were most anxious to push forward the manufacture of those guns; and very lately he had himself asked Sir William Armstrong whether any sum of money which would enable him to procure additional labour or more rapid machinery would assist him in the quicker production of those guns. To that question, Sir William Armstrong replied that he had every means, and as much machinery as he could possibly use, and that he could not make the guns any faster than he was doing. Sir William Armstrong had two factories, one at Woolwich and the other at Newcastle, in constant work, and he believed that every exertion was being made to produce the guns as rapidly as possible." That would go to confirm the statement that there was a very considerable pressure, and that both factories were quite in full work at that time?—Yes, quite so.

5090. Colonel *Dunne.*] The pressure must very much depend on the demands made from the Admiralty, I suppose?—No doubt it would depend on the demands from both departments. A period came when that pressure ceased, and when, instead of having more orders to give than could be supplied, we had much fewer orders to give than would keep the plant of the Elswick Company in full work, and it was in consequence of that that it became necessary to conclude that agreement.

5091. But circumstances might arise such as another war, which would again necessitate the rapid production of guns, in excess, perhaps, of what one factory would be equal to?—If such circumstances arose as to require an extension of production, we should have to come to Parliament to provide for that in the best way possible; but it would have been a most imprudent thing to keep on paying the Elswick Ordnance Company under this guarantee for the non-employment of their machinery, when we had not the means of keeping their plant in constant work.

5092. Mr. *Vivian.*] If that necessity arose, would your Lordship recommend in that case that the manufacture of the guns should be given over to private individuals, under a guarantee by the Government against loss?—I should take that course which at the time seemed the best.

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5093. *Chairman.*] How long has your Grace been First Lord of the Admiralty?—Since July 1859.

5094. Does your Grace consider the Admiralty responsible for all guns demanded for the Naval Service?—The Admiralty is responsible for all guns demanded for the Naval Service, with this limitation, that the Admiralty have only one establishment with which they can deal. All they can do is to send to the War Department and say what guns they think they want; but in case of any new gun they must rest entirely on the War Department for opinions with regard to that gun.

5095. But still they are allowed entirely to form their own opinion with regard to whether any particular gun shall be introduced into the Naval Service or not?—Yes; but they have little opportunity of judging of guns, except such guns as have been sanctioned by the War Department. For instance, if the Admiralty had wanted in 1859 to adopt at once the French gun, the Admiralty would have been placed in considerable difficulties with respect to obtaining that gun; they could not have obtained that direct from the War Department.

5096. But suppose, for instance, that your Grace had thought fit to adopt the French gun, would it not have been competent for you to direct the War Department to manufacture the guns according to the pattern which you supplied for the Naval Service?—It would have been taking a responsibility which the Admiralty never have taken to set aside the Ordnance Select Committee. Every gun has been passed by the Ordnance Select Committee, before we have adopted it.

5097. But is not the Admiralty represented on the Ordnance Select Committee?—Yes, there is a naval officer.

5098. And that naval officer is selected by the First Lord of the Admiralty, is he not?—He is selected by the First Lord of the Admiralty for the time being.

5099. And there is a naval officer in the War Department who conducts the correspondence between the Admiralty and the War Department?—Who conducts the correspondence on all questions with respect to requisitions for guns.

5100. Did your Grace consider that the Armstrong 100-pounder guns had been sufficiently tried when the Admiralty demanded them for the use of the Navy?—In order to answer that question, I must go back to the time when I came into office; when I first came into office in July 1859, the Committee will remember that there had been a great effort made to strengthen the Navy of this country, and to strengthen all our means of defences, and that, at that time, one of the many questions before me was the question of Ordnance. I communicated with the War Department, therefore, to know how the question of cannon stood, and especially with respect to rifled cannon. Lord Herbert, who was then at the War Office, sent me the papers; first, he sent me a report by Colonel Lefroy, of August 1858; a report on rifled guns, which condemned a great many guns that had been submitted to the Ordnance Select Committee. It condemned the Lancaster gun; the Jeffrey's gun; the Wahrendorf gun; the Whitworth gun (as having burst); the French rifled gun; Engstiöna's gun; Church and Goddard's gun; and with respect to Mr. Bashley Britten's gun, the report stated thus:—"The data are so defective that it can only be said that there is no certainty on the subject." When, therefore, this report was submitted to me, I looked naturally to the next report, which was the report of November 1858, and there I find condemned the Vandeleur gun, Irving's gun, Lynal Thomas's gun, and Lawrence's gun. That report said that the Committee had come to the conclusion that those guns offered so little advantage in point of accuracy over the smooth-bored gun that they were unwilling to recommend the Government to incur the expense of carrying on any further experiments with them. The report went on to say: "The practice with Mr. Armstrong's gun is forwarded herewith. The Committee have to remark on the penetration of the 18-pounder in solid oak, and on the range of the gun when fired at an angle of elevation of 35 degrees; both the penetration and the range are probably the greatest upon record." I had, therefore, before me a condemnation of almost all the other guns that were known at the time, and great praise of the Armstrong gun. I then found that, acting upon that in December 1858, the previous Board of Admiralty had suggested that Mr. Armstrong should make a gun of large calibre to carry a projectile of 70 lbs. I found also, that in the beginning of January 1859 the War Office had entered into an agreement with Sir William Armstrong, under which he was to turn out in a year various guns, some of which were to be of large calibre. When we came into office in July 1859, we had it represented to us (I think by Captain Hewlett) that it was desirable to have some Armstrong 40-pounders for the upper decks of vessels of war, and, accordingly, we applied to the War Department for some of those 40-pounders, that was in July 1859. In September 1859, I received from Mr. Herbert an intimation that Sir William Armstrong proposed that the gun which had been formerly asked for, namely, a 70-pounder, instead of being a 70-pounder gun, should be a gun of that same weight, but should throw a projectile weighing 100 lbs. He said that one gun had been tested with such a projectile, and that it led him to make that modification. I had of course a great deal of communication with Mr. Herbert on the subject of guns for the Navy; first, with regard to what I thought at first we might have done, which was to adapt the existing guns for naval purposes, and on that subject the Committee are probably aware that there were several modes attempted. The one that appeared at first most likely to be successful was sending what may be called a block of the still unbored gun, as it was made at the Low Moor Ironworks, to Sir William Armstrong, to bore it on what he called the shunt principle, that is to say, the muzzle-loading cast-iron gun. At first, it was thought that that gun would answer; eventually that gun was given up, as, in fact, were all attempts to rifle cast-iron guns.

5101. Does your Grace concur with the opinion of those who thought that none of those guns ought to have been proceeded with?—I think that the experiments tended very much to that conclusion. No doubt, as they stated to me in one of

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the letters from the War Department, you could rifle and hoop cast-iron guns, for small charges of powder; but if the sailors will overload them they will burst, and be very destructive; and I know that the sailors, if ever they come into action, would overload the gun and double shot them, and do everything which sailors are apt to do in the excitement of action, so that the guns would come to great discredit, and that I should be responsible for having taken such guns into the Naval Service. I was, therefore, very anxious to obtain some wrought-iron gun. The inconvenience that attended the Armstrong gun was this, as the Committee are well aware, that in adopting the rifled gun you necessarily adopted the breech-loading principle, because the projectile, coated with lead, was larger than the muzzle, which involved loading from the breech. In deciding, therefore, and in asking for a rifled gun of Sir William Armstrong's pattern, I necessarily asked for a breech-loading gun, because there was none other. Two very different questions, and both difficult questions, were therefore combined in one. That was what I may call the inconvenience of having to deal with that gun at the time.

5102. Does your Grace consider the 100-pounder has proved itself a satisfactory gun for the naval service?—I think not entirely; I believe that it had some great advantages and that it had some defects; as long ago as October 1860, I received a letter from Mr. Secretary Sidney Herbert, sending us the Report of the Ordnance Select Committee, and asking whether a gun of an intermediate calibre between the Armstrong 40-pounder and the 100-pounder would be required, and proposing that the Committee should have a conference with the Admiralty upon the subject of such intermediate gun; looking back to that paper I find I wrote upon it in the corner, "It is desirable that the 100-pounders promised should be delivered before guns of a new calibre are commenced; the 100-pounders will be most serviceable as pivot guns, and it is as yet doubtful whether the Armstrong guns will be generally used as broadside guns." That I wrote in October 1860; I was anxious to obtain some 100-pounders to try them as pivot guns; I had great doubts whether they would answer completely as broadside guns; subsequent experience has tended to confirm the opinion that though it is very desirable to have some on the upper decks, and some in gun-boats, yet for broadside purposes it has not proved so good a gun as we expected; the Committee must remember the difficulty we were in; we had a report that the Armstrong gun had the greatest range and the greatest power of penetration of any gun tried; when we came to try it ourselves that was not confirmed by the facts: the Armstrong gun at a great distance may have had greater power of penetration, but for naval purposes at 200 yards it certainly had not the greatest power; our old 68-pounder is a more powerful gun than the 100-pounder Armstrong gun.

5103. In fact, if your Grace was fitting out a fleet for active service to-morrow, would you recommend that the greater number of the guns should be the old 68-pounders?—Not now; if I had them I would rather have a more powerful gun; I consider that what we have asked the War Office to provide us with would be the sort of gun that we require; I want a gun in which we can fire about 25 lbs. of powder, and I should not object to its being a smooth bore if I could have a gun which would carry a projectile weighing about 140 or 150 lbs.

5104. Does your Grace concur with the opinion expressed by some of the witnesses before this Committee, that it would be desirable, even if you had a rifled gun, to have a rifled gun which could also be used with round shot?—Yes; I find, looking back to my papers (I have only had time to look back very lately), that so long ago as November 1860, I wrote to Mr. Whitworth to ask whether he could make a rifled gun which could be used also with spherical shot; I have his reply here, stating that he saw great difficulties in the way, and thought it could not be done; that was November the 17th, 1860; he says, "With regard to the use of spherical shot in rifled cannon, I beg to state that as solid elongated projectiles from their length and form require a much smaller calibre as compared with that for a spherical shot of the same weight, I do not see how spherical shot can be made available." I thought, therefore, that I should not get any help from Mr. Whitworth in that respect, though I thought it was a desirable object to attain.

5105. Have you had any experience of Captain Blakeley's guns?—No; I think that Captain Blakeley did write once to the Admiralty respecting his gun, but the Committee are aware that the Admiralty have no money to buy guns with, and all I could do, was to refer him to the War Department; I had no such knowledge of Captain Blakeley's gun as would have justified me in sending to the War Department and begging them to provide it.

5106. Would your Grace kindly state what requisitions for guns the Admiralty have lately made?—Up to the end of 1860 we had never received any 100-pounders. Early in 1861 we obtained a gun, and in February 1861 we asked for 200 110-pounder Armstrong guns.

5107. What experience had the Admiralty had of those guns before they gave that large order?—We must have had a report from the War Office as well as, I think, from Captain Hewlett, because he had had the gun by that time. There must have been some report, because it was not till after we had obtained the gun that we gave the order, and we certainly obtained the gun early in 1861.

5108. Perhaps I shall make my question more clear by reading to your Grace a question and answer from Sir William Armstrong's evidence. "Can you state upon what series of experiments that gun was approved? None at all; there was such an excessive pressure for rifled guns at that time, there was no time for experiments; and it was one of the great difficulties which I had to contend with, that I was obliged to produce the guns under those conditions." "Were 673 100-pounder guns, costing between 400,000 *l.* and 500,000 *l.* to the country, adopted without any series of experiments being made? No, certainly not; but it was some time before the first gun was ready, and probably about 100 were ready before we could test one"?—The whole question of those guns is involved in confusion, from the very name. When you speak of a common gun, and say a 30-pounder, you mean a gun that shoots a 30-pound sphere, but a rifled 30-pounder may be a 70-pounder, and a rifled 150-pounder may be a 300-pounder. That was what I referred to when I stated that after it had been found that the gun which was originally to throw a 70 lb.

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a 70 lb. shot (a 65 cwt. gun) had been tested with a 100 lb. shot, and was found to answer, it was proposed to make those guns 100-pounders. The War Department seemed to think that the gun could throw a 100 lb. shot, and of course I thought it an advantage at that time to have a 100 lb. shot instead of a 70 lb. shot. At that time we had had no sufficient experience with regard to velocities. In fact, the apparatus that was afterwards invented to test the initial and terminal velocities was not brought into use, and therefore we had no means of knowing the different values of those guns in that respect. When I heard that a 70-pounder could throw a 100 lb. shot, I considered that it would be a gain. Subsequent experience shows that it is far more important to consider the length of the projectile in proportion to the diameter, and to a great many other matters, which at that time were not brought before me in any way. I thought it so much an advantage to have a 70-pounder gun that could throw a 100 lb. shot, that I considered it probable that the armanent of the "Warrior" would have been all 100-pounders, and it was not till we tried a 100-pounder and a 68-pounder against Captain Cole's cupola that I became aware that the 68-pounder struck a harder blow than the 100-pounder at short range.

5109. Your Grace has stated the nature of the requisitions that you have lately made upon the War Department, but supposing that you were obliged to arm a fleet for active service to-morrow, with which of the guns that are now actually in possession of the country would you arm that fleet?—We have nothing better now for close quarters than the 68-pounder. The question of finding out what is the best gun is a question involving a great many different examinations. First of all, we must inquire what the metal should be which is to be used for making the gun, whether cast-iron, wrought-iron, or homogenous-iron, or steel of any other kind. Then when we have ascertained that, the question arises, would the same metal be suitable for different sizes of guns. Then arises the mode of construction of the gun; whether it is to be on the coil principle, or whether it is to have a lining of a different metal inside, or whether it should be made entirely of a block. All those questions have been brought before me at different times. But to come to a satisfactory decision on these points will, I am afraid, take years. I do not think, therefore, I could say what gun may be considered the best gun a few months hence.

5110. Does not the last answer which your Grace has given show that at all events there is much to be said for the policy taken by the French—adapting in the best way they could the existing gun, pending all those experiments?—All our reports are, that the French gun was a very bad gun, and that it was almost valueless. As against iron plates, a gun with 10 lbs. of powder could not, it appeared to me, be a very effectual gun; it seemed to me that if we stopped there we were advancing a very little way indeed. The requisition which I mentioned was in February 1861.

5111. General *Peel.*] Was that the first requisition for the Armstrong gun?—No; because there was a requisition so long ago as December 1858, which was a requisition that Mr. Armstrong should make a gun of large calibre, as an experimental gun. The first order after I came into office was on the 15th of July 1859, which was a requisition from the Admiralty for 40-pounder Amstrong guns for the upper deck. The next requisitions, I think, were in 1860. In 1860 we wrote again, asking for guns; but, as I have said, there was a requisition in 1859, because when I received a letter (and I think there is a public letter to the same purport) from Mr. Secretary Sidney Herbert, recommending that the 70-pounder shot gun should throw 100 lb. shot, we begged, I think, to have some of those guns for trial on board the "Excellent;" and I find that at the end of 1860, or the beginning of 1861, we had a gun of that kind, which was sent to the "Excellent."

5112. It was subsequently to that trial that that order was given for 200 110-pounders?—Yes; it was represented to me, and I believe it was the fact, that if you made the machinery, the great cost was over; that if you made the machinery, you might as well have several guns, so as to have different opportunities of trying them. The great question was, whether we would have a gun at all of that size; and if we did have a gun of that size, it did not seem so very important the exact limit of the number we should take. In September 1861, I find a letter from the War Department, asking us whether any more guns would be required during the year, and we answered that, as regarded the Navy, 200 more would meet all the requirements up to April 1862.

5113. Captain *Jervis.*] Do you mean 200 100-pounders?—I am not sure whether they were all 100-pounders; but I could tell you the total number of 100-pounders which we have asked for.

5114. Mr. *Baring.*] This is a copy of your Grace's letter (*handing a Paper to his Grace*)?—Yes. "Admiralty, 4th February 1861. Sir, Having laid before my Lords Commissioners of the Admiralty Captain Caffin's letter of the 2d instant, Estimates, 1861–2 P., requesting to be informed what number of 100, 40, 25, and 12-pounder Armstrong guns will probably be required for the use of the Royal Navy during the ensuing financial year, I am commanded by their Lordships to state, for the information of Lord Herbert, that, as mentioned in the Admiralty letter of the 5th December last, my Lords have proceeded hitherto upon the understanding that 200 40-pounder guns, 100 100-pounder guns, would be furnished with as little delay as might be practicable. In fixing the numbers above-mentioned, my Lords have been hitherto guided not solely by the requirements of the Naval Service, but also by the consideration that the introduction of these guns into Her Majesty's ships should, to a certain extent, be gradual; having, however, in view the extreme importance of improving the armament of the Navy, and looking also to the experience already acquired of the efficiency of the Armstrong guns, their Lordships are of opinion that an increase to the numbers demanded may be made with advantage. They would, therefore, now propose that in addition to the numbers which have been already demanded, there should be a further supply in the course of the ensuing financial year of 100 100-pounder guns, and 300 40-pounder guns, making altogether, with those previously demanded, a total of 200 100-pounder guns, and 500 40-pounder guns. My Lords conclude that all these guns can certainly be supplied as breech-loading guns; but should it be practicable to add to these numbers a further supply of 300 100-pounder muzzle-loading Armstrong guns, their Lordships are of opinion that

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the additional supply will not be more than can be advantageously introduced into the service in the course of the ensuing year. To the above-mentioned guns, my Lords would also be glad to add 250 25-pounder guns, and 250 12-pounder guns, to replace respectively the 24-pounder and 12-pounder howitzers, either in gun-vessels or for boat service?—I think that those requisitions were after we had had some experience of the 40-pounder Armstrong gun in China. Then, on the 9th of March, I think, of that year, a proposition was made by Captain Hewlett for the introduction of some still larger guns, monster guns as they were called, to try against batteries, and against iron plates. That requisition was forwarded to the War Office in March 1861. Then in May 1861, the Admiralty requested Armstrong guns, and many of those were 100-pounders, for the ships on the Mediterranean station, and the first and second division of the steam reserve, and also, some that would be in readiness for gun-boats, and many of those were 100-pounders. In the mean time, we had not obtained the guns which we had asked for; we sometimes write for guns which are not received, and that leads to a little confusion. We were only in many cases shadowing out to the War Department what they would have to provide in future, because they told us that the works required to be kept continually going, and that if they did not keep on their men, they would afterwards have to produce the guns at greater expense. So lately as last October it was represented to us that the works, both at Woolwich and at Elswick, were at a stand for want of orders, and it was proposed to us then to make a number of 32-pounder muzzle loading smooth-bored guns, with a view afterwards to rifle them. That was a proposal made really that they might not turn away their workmen, but go on employing them. To that we answered that we did not approve of those guns; that we observed that none of the 70-pounders which we had asked for for two years had yet been made, and we declined the 32-pounders therefore, and we declined any more 100-pounders. But we added, that if they wanted to employ the men, we wished for 20 150-pounder smooth bore guns properly strengthened, 10 of them to be made at once, and the other 10 we proposed should not be commenced till the others had been tried. The Committee are aware that the first 150-pounder that we had tried, had blown the breech out, but otherwise, it was shown to be a very powerful gun, and I wanted some guns of that kind as I still want them for the towers of Captain Coles. I should like to observe, that there were a great many questions with regard to those guns; sometimes stopping them while some further experiment was being tried, and sometimes going on with them. I find, for instance, that in August 1861, the War Office proposed to us, to proceed with the 100 guns, the manufacture of which had been suspended, and we approved of their going on with them. It would be a very lengthened matter to go into all this correspondence with regard to the guns during all those years. I was in the constant habit of writing to Lord Herbert, and he was in the constant habit of writing to me, and coming to me, and sending Sir William Armstrong to me. The manufacture was sometimes to go on, and sometimes to stop, so that it is now very difficult to give the Committee a clear idea of all that did take place.

5115. Are there any further requisitions besides those that your Grace has already mentioned?—I think there was no other requisition that I can find till October 1862, which was the requisition which I have just read. There was a requisition in November 1862, for the War Department, to supply two of the 110-pounders with the side breech-loading arrangement, as trial guns for the "Excellent" and the "Cambridge." I think that is the last requisition.

5116. Has your Grace had any experience with regard to shunt guns?—I was very anxious to get a shunt gun of some kind, because I felt that we were trying two experiments at the same time, and most inconveniently, one as to the principle of rifling, and one as to the principle of breech loading; I wanted, therefore, if we could arrange it, to see the merits of the two systems separately tested; I was very anxious if we could have obtained a shunt gun to procure it, but the cast-iron shunt gun, as I have stated, was after a time abandoned; then the wrought-iron shunt guns had been made of various kinds, with different modes of grooving, and they seem to have given good results, but we have never had any; I do not know whether they have been finally passed by the Ordnance Select Committee; I think they have not been in a state in which we could have made a requisition for them.

5117. Your Grace stated that the French guns are always used with very light charges of powder, but we have had evidence before us with regard to a 6¼-inch French gun, the charge of which was 27 lbs. of powder; it is stated that two-thirds of the whole weight of the gun is cast-iron, to which steel rings are added; Captain Blakely was asked at Question 4866, "Do you know whether they have stood any very large quantity of firing?" to which he replied "Yes, very large, one gun especially, the gun whose endurance recommended the adoption of the principle into France, was fired 3,000 rounds, with one charge of powder and three shots, which was of course a most remarkable case of endurance"; has your Grace received any report at the Admiralty with respect to those guns?—I have heard of experimental guns that have been very good every now and then, and then I often hear afterwards that the gun has burst; what I have looked to is what gun they take in the French navy, now what they have got in the French navy generally, is a gun with a small charge of powder (one thirteenth), and that is an ineffective gun in my opinion.

5118. Sir *Frederic Smith.*] Can your Grace state whether naval officers in command of ships are required to send to the Admiralty periodical returns of their opinions of the various guns which they have under their observation?—Yes, we have been especially anxious with respect to the Armstrong guns, and we have had reports from all parts of the world.

5119. Do those reports generally tally?—I think the course has been this, naval officers like to have some Armstrong guns, and they are dissatisfied if we do not send them some, but very often when they have had them they write back and find fault with them, saying they will not answer for all purposes, but I think for chase guns and pivot guns on deck, they approve of them generally; the reports which I have had from Sir Alexander Milne are not very favourable to the Armstrong guns between decks, I think.

5120. You think the objection is chiefly to the Armstrong guns between decks?—Yes.

5121. Is

5121. Is that from the offensive smell?—Partly from the offensive smell, and also because they said at night quarters, and in the movement and hurry of action, they think they are too complicated a gun to work, and also that it is difficult to see at night quarters that they are properly screwed up, and other objections of that kind, which I think are sound objections to the use of these guns generally as broadside guns; but the great objection to these guns now that we are going on with iron navies is that they have not power enough.

5122. Not power enough at short ranges?—No.

5123. Has their power been tested at long ranges against the smooth-bore gun upon iron plates?—I suppose at long ranges there is no doubt that they would keep up their power; but most of our experiments with iron plates have been at 200 yards, though sometimes we have tried 600 or 800 yards.

5124. Have any suggestions been made to the Admiralty by officers in command of ships for improvements in Armstrong guns?—Yes; we have had some suggestions. For example, with respect to the sighting of them, the suggestion made by Captain Jerningham; and I think they were adopted in the smaller guns when he was in command of the "Cambridge."

5125. Are the different reports of that kind all sent to the War Department for their guidance?—Yes, always.

5126. You have stated that a good many of the 40-pounder guns were introduced into the service; was that upon the reports of officers of the Navy?—Yes; they were very much praised.

5127. Captain Hewlett praised them very much, did he not?—Yes; he has generally been in favour of the Armstrong guns, I think.

5128. Is that 40-pounder gun now generally approved of?—I think so; but since the 100-pounder has been in use I think less notice has been taken of the 40-pounder.

5129. Your Grace has stated that you have sent in requisitions for 150-pounders; are those 150-pounders now in course of construction?—I believe so; I believe there are some. The question was with respect to the mode of strengthening the breech. I think the mistake which we made at first was what I have indicated from the evidence, which is, that we intended to obtain a 70-pounder; and we then (as there was no limit to the length of the shot), without adding to the weight of the gun, made it into a 100-pounder. The temptation of the elongated projectile is that of putting a greater weight than you ought to put into the gun.

5130. Requiring, of course, a larger charge of powder, which the gun is not capable of resisting?—Which the gun is not capable of resisting. Then I may observe that the mode of testing the gun is a very unsatisfactory one. As long as you had the old cast-iron gun it did not much signify putting in a double charge of powder; but when you come to fire a gun rifled up to a certain point, and put in a double charge of powder, your charge of powder comes down to the part where it is rifled, and you seriously damage the instrument.

5131. Sir *John Hay.*] Is not the principal objection taken to the Armstrong gun the weakness of the vent-piece, along with the complication in loading?—Yes; the weakness of the vent-piece is a great objection in the Armstrong gun. The Armstrong segment shell is a beautiful invention. The difficulty has been the vent-piece.

5132. Do you not think that it would be desirable to have a rifled gun for naval purposes, which, with a large charge and a short projectile, would have a great initial velocity for short ranges, and which could also be used with a lower proportionate charge of powder, and a larger shell, with a less initial velocity, along with great precision, at long ranges?—Yes; that is the sort of gun which, I think, we want.

5133. Have not a great many experiments recently been made with shot weighing about 69 lbs., fired from the 110-pounder Armstrong gun, with the old 68-pounder charge of powder?—Yes.

5134. Has not the initial velocity of that projectile so fired been found to be greater than that of a 68-pounder?—Yes; and that has helped to correct one of our errors. It was imagined that a smooth-bore gun must have greater velocity than a rifled gun. That was an error which we have corrected gradually with increased experience. Those experiments have tended to put us right on those points.

5135. It has been ascertained by experiment that the 110-pounder can be used at short ranges, and with the same charge, as the old 68-pounder, with a heavier shot, with the same effect?—Yes.

5136. The same tube can also be turned to another purpose, namely, precision and great range, with a lower charge of powder, performing a duty which a smooth-bore gun is not capable of performing?—Yes.

5137. You would then have a gun which combined great power and great initial velocity at a short distance; and the same gun would also do with another projectile at a greater distance?—Yes.

5138. Do you not think that that would be very desirable?—I think that would be a very desirable object to attain.

5139. Has your Grace's attention been called to the plan for strengthening and improving the breech of the present Armstrong gun, suggested by Mr. Westley Richards?—Yes. He brought me a model of it. It looked very well in the model. It is entirely a question of experiment; and I think it is worth trying. Certainly, the present vent-pieces of the Armstrong gun, with all its improvements, and the improvements in the metal, does not seem perfect. We want it strengthened in order to give the men perfect confidence.

5140. Have not orders been given from the Admiralty to reduce the charge of 14 lbs. to 12 lbs.?—Yes; but that is an unsatisfactory way of meeting the difficulty, because what we want is to increase the charge.

5141. But if a satisfactory solution were arrived at, either by adopting Mr. Westley Richard's proposal, or any other proposal, do you not think it would be desirable to attain the double advantage of the present description of tube, rather than to resort to the expedient of having two descriptions of gun in one ship?—Yes, certainly; if one gun will answer two purposes, it is a very great gain.

5142. Captain *Jervis.*] I did not quite understand your Grace to state whether the Admiralty were entirely responsible for the guns for which they made a demand on the War Office?—We tried to obtain the best gun that we know of; but we have not the means that the War Office have of testing every sort of gun, because we do not deal

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deal with the inventors as the War Office do. If an inventor writes to me that he has got a gun for naval purposes, I am obliged to refer him to the War Office. I may have seen his model or his drawings, and I may have some reason to say that I think well of his plan, but I seldom take upon myself that responsibility, unless I have some official or scientific authority for saying to the War Office that they should try it. Therefore I can only look to the War Office for guns that have been approved by them.

5143. Such an inventor would be referred to the Ordnance Select Committee by you?—Yes.

5144. Has there not been for several years a naval officer acting as vice-president of the Ordnance Select Committee?—Yes.

5145. May he not be said to represent the Admiralty?—Yes, but I do not think that inventors are very fond of the Ordnance Select Committee. They used to come to me, many of them, because they said they did not like the Ordnance Select Committee.

5146. Sir *John Hay.*] I think I hardly understand your Grace to state that the vice-president of the Ordnance Select Committee represents the Admiralty in any sort?—No, he does not represent the Admiralty.

5147. Captain *Jervis.*] But he is appointed by the Admiralty?—Yes, he is appointed by the Admiralty.

5148. There is at the War Office a naval director of Ordnance, is there not?—Yes, who attends to the requisitions.

5149. Who furnishes the Admiralty with any report from the Ordnance Select Committee with respect to any inventor?—Yes.

5150. All that is given to the Admiralty?—Yes, but sometimes not till considerably after the experiments have taken place, so that it is difficult to be quite aware of what is going on.

5151. But the Admiralty have the further advantage of a ship at Portsmouth for the sole purpose of experiments, have they not?—We have a ship at Portsmouth which makes various experiments both with regard to guns and iron plates.

5152. I suppose any suggestions which the Admiralty make to the War Office with respect to further experiments as to any gun are always carried out?—Yes, but the "Excellent" only tries experiments with guns that have passed the War Department. It does not try unproved guns.

5153. Is it your opinion that the War Office has any means of ascertaining that there is any improved gun which the Admiralty has not?—Certainly; because they have a committee and the means of making any gun, while we do not make guns.

5154. Do you not frequently require the War Department to make guns to carry on certain experiments?—Occasionally we have requested the War Department to buy guns and to make guns. I asked them to do so particularly with respect to Mr. Whitworth's gun. I wrote and asked them to purchase that gun after I had tried the gun of Mr. Whitworth on the "Trusty," where it was successful in sending a projectile through a 4-inch iron plate. I wrote to Lord Herbert on the subject, and asked him to see whether he could arrange with Mr. Whitworth for more guns of that description, or rather at first for some gun of that description.

5155. Do you think it would be advisable for the Admiralty to have a separate Committee of its own to try experiments with guns?—No; I think not. It is the French system to have the guns for the Navy provided by the Navy separately from those of the Army. I think that system would entail considerable additional expense, and I do not know of any equivalent advantage which would be gained by it.

5156. Then I suppose we may conclude that the large number of guns that have been demanded by the Admiralty for the Navy were made after very careful inquiry with respect to their suitableness for the Naval Service?—Yes; we thought, and I still think, that the guns are very suitable. But the question was as against wooden ships. They were a most powerful gun for that purpose, and with a shell of very great power. But when we came to the question, how to engage iron ships, all the conditions of the case were altered. With respect to wooden ships and our naval power in all parts of the world, I think a certain proportion of Armstrong 100-pounders are very desirable, and I do not think we have too many of them.

5157. You do not think that you have now too many of them?—I do not think we have too many of them.

5158. General *Peel.*] Your Grace commenced by stating that when you were appointed to office you found two reports existing with respect to the Armstrong guns?—Yes.

5159. The first report was from Colonel Lefroy to me, on which report the Ordnance Select Committee was appointed?—Yes.

5160. The second report was the report of that Committee which recommended that the Armstrong gun should be adopted for special service in the field?—Yes; and that Committee condemned almost every other gun at the same time that they spoke in great praise of the Armstrong gun, both with respect to range and penetration.

5161. The report contained these words, "The committee on rifled cannon have now the honour to recommend the immediate introduction of guns rifled on Mr. Armstrong's principle for special service in the field." That was all that their recommendation extended to?—That was all that their recommendation extended to, but they indicated more than that, because they condemn every other gun; speaking of this gun in point of range, and in point of penetrating power, as so superior to every other gun, and that, of course, induced me to believe that it was the gun which it was desirable to have for the Navy.

5162. But their recommendation merely extended to that as a gun for special service in the field?—Yes.

5163. In January 1859, you stated that the Government had given orders for some of those guns of larger calibre?—Yes.

5164. I think your Grace will find that there was one 70-pounder ordered at the request of the Admiralty in consequence of a letter from Captain Hewlett, dated 16th of December 1858, in which he says, "I beg to submit to their Lordships, that it would be advisable that Mr. Armstrong should be invited to construct as soon as possible for trial a gun of large calibre, say to carry a projectile of 70 lbs. weight"?—Yes; but I have a memorandum besides, which was sent to me with that report, in which it is stated that the number of guns that were ordered on the 24th of January, and the 4th of March 1859, were six 20-pounders, 20 25-pounders, and 70 40-pounders; and there is a note at the bottom to this effect:

"Besides

"Besides these, it is understood that 100 guns, calibre unknown, will be produced at the Rifled Ordnance Factory prior to the 31st of March 1860."

5165. They would have been included in the Estimates of 1859-60?—Prior to the 31st of March 1860 would be included in the Estimate for 1859-60.

5166. Then the only amount taken in the estimates for 1859 was the 73,000*l.*, which was all for land service-guns?—Yes.

5167. And there was not a single gun ordered, or included in that Estimate, for the Naval service, except the 70-pounder experimental gun?—Just so.

5168. Now, is not the course of action between the War Office and Admiralty this: that the War Department, previously to the preparation of the Estimates, call upon the Admiralty for a return of the number of guns they will require during the next financial year?—Yes.

5169. But the War Department are not responsible for the natures of those guns; and it is for the Admiralty to state what description of guns they require?—Yes, that is the usual course; but when we come to new inventions, the usual course of things is altered, because, if we hear that a much better gun can be made, for instance, that it is as easy to make a 100-pounder gun as a 70-pounder gun, the Admiralty would naturally ask for the better gun, believing the statement that the gun could be so made.

5170. Your Grace states that on the 17th of November 1860 you made an application to Mr. Whitworth for a gun; was that application made independently of the War Office?—I wrote to Mr. Whitworth, to know whether he could make such a gun; I did not make an application for a gun, but in the course of my communications with Lord Herbert I wrote to Mr. Whitworth to know if he could make a gun which could be used with spherical shot as well as elongated shot. Of course I should not have ordered that gun, but I should have written to Lord Herbert, and asked him to see Mr. Whitworth.

5171. But the course which you adopted showed perfectly independent action on the part of the Admiralty with respect to the War Office, did it not?—That was not action on the part of the Admiralty, it was a private letter of mine to Mr. Whitworth, and I was always acting in concert with Lord Herbert; I could not have ordered any gun, because I could not have paid for it.

5172. But the Government, when it went out of office, had not taken upon itself to recommend any gun to the Admiralty, and the only gun made for the Admiralty was that 70-pounder experimental gun which was made upon the Admiralty's recommendation?—The first requisition of the Admiralty for Armstrong guns appears to have been on the 15th July 1859. I know that in July we forwarded a proposal of Captain Hewlett, and asked for some 40-pounders; that was the commencement of our application for Armstrong guns.

5173. There is a recommendation of Captain Hewlett's upon the subject, contained in a letter of his to the Admiralty on the 13th of July?—Yes, and we forwarded that to the War Office on the 13th of July, asking for those guns.

5174. Upon the recommendation of Captain Hewlett, and not that of the War Office?—Quite so.

5175. The Admiralty had tried the Armstrong guns on board the "Excellent"?—Yes; and thought very highly of them.

5176. Your Grace has also stated that, on the 4th of February 1861, you made a very large requisition to the War Office for guns, because the experience of the Armstrong guns had given great satisfaction?—Yes; we thought very well of the Armstrong gun.

5177. Mr. *Vivian.*] Could your Grace state what series of experiments preceded the final adoption of the 110-pounder into the naval service?—I cannot state what the experiments were with the 110-pounder; most of our experiments at that time were made with the 40-pounder. We considered that there was no reason to suppose that what answered with the 40-pounder would not also answer with the 100-pounder; they were coiled guns made upon the same principle, and we were told that upon that principle you might make a gun of any size.

5178. Let me refer your Grace to the answer of Sir William Armstrong on the 10th of June to Question No. 3549: "Can you state upon what series of experiments the 110-pounder gun was approved?—None at all; there was such an excessive pressure for rifled guns at that time that there was no time for experiments, and it was one of the great difficulties which I had to contend with that I was obliged to produce the guns under those conditions." Is that answer substantially correct?—That is quite correct, I dare say, with respect to the 110-pounder gun. Our experiments were with the 40-pounders.

5179. It was not anticipated, then, that the failures of the vent pieces which have occurred would occur, I suppose?—They have occurred in the 40-pounders. I have myself seen the vent pieces of the 40-pounders go three or four times.

5180. Then in spite of those failures of the vent pieces, your Grace still considered that it was desirable to introduce those guns so extensively into the service?—We had not had so much experience; we had some vent pieces going, but we were always told, and to some extent correctly told, that by improved metal we should obtain vent pieces that would not give way. There were continued improvements going on from day to day, and so much so that, as to the 40-pounders, that were first sent to us, I have a letter from the War Office saying that we should have them for the present, but that we should very soon have improved 40-pounders, and return those into store.

5181. Is your Grace satisfied now with the condition of the vent piece of the 110-pounder?—I am not quite satisfied with any of the guns that we have yet. They are all capable of improvement.

5182. In answer to a question of an honourable Member, I think your Grace stated that there were not, in your opinion, too many 110-pounders. Did that refer to the guns afloat or to the guns that have been made?—I think there have been issued to June 1863 two hundred and ninety-six 110-pounders, and there are in store 339, which makes a total of six hundred and thirty-five 110-pounders; I do not consider that too many for the service of the Navy all over the world.

5183. In 1858 I think I understood your Grace to refer to successful experiments which had been made with Mr. Whitworth's gun when the 4-inch plate of the "Trusty" was pierced?—It must have been later; it was in 1860, I think. I was not in office in 1858. Mr. Whitworth may

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have pierced an iron plate at that time, but when I saw the experiments it must have been in the summer of 1860. I was down at the Nore. We went down with the gun and fired at the "Trusty," and pierced her very easily. There is no doubt, I believe, that he could have sunk the "Trusty" with one or two shots.

5184. Your Grace referred to a correspondence which occurred with the late Lord Herbert; can you state what was the reason that the manufacture of the Whitworth guns was not proceeded with at that time?—The Ordnance Select Committee, I think, never passed the Whitworth gun properly.

5185. Was any Whitworth gun manufactured at that time upon the principle adopted by Sir William Armstrong of wrought iron coiled?—Yes. Mr. Whitworth, as I understand (I hope I do not misrepresent him), objected to the coil principle, and thought that the gun ought to be made on the homogeneous principle, worked out of a solid block of iron; but that at present he could not get that iron of the size and quality which he wanted, and that therefore he would like to have his principle of rifling tried by having a gun made at Woolwich in the way that they made them for Sir William Armstrong.

5186. Was that in 1860?—I have not got the exact date; I think that it was after the trial at the "Trusty," which was with a gun that he had brought down himself.

5187. Was it your Grace's desire, seeing the success of that experiment, that guns should be manufactured on Mr. Whitworth's principle of rifling?—I thought there were great advantages in his plan, and great simplicity; the projectile might be knocked about the deck and not be injured.

5188. In some way or other your Grace's suggestion was not carried out?—There were two disadvantages. First of all, we never obtained the material that Mr. Whitworth considered necessary for doing justice to his principle. I believe now he is able to make the gun; but at that time he did not think that he could obtain the homogeneous metal.

5189. Mr. *Baring.*] It would probably be in consequence of those trials, that the late Lord Herbert ordered four guns to be made in 1860, under Mr. Whitworth's directions, at Woolwich, in order that they should be muzzle-loading guns?—Yes, I believe that was what led to the further trial of the guns.

5190. So that your Grace's suggestion would have been concurred in by Lord Herbert, and measures taken accordingly?—Yes; Lord Herbert was very anxious to try the guns; I do not think the principle was ever approved of by the Ordnance Select Committee; I do not think they ever approved of that mode of rifling, I think they objected to the working of iron against iron.

5191. Mr. *Vivian.*] But that without going through a series of experiments, the Committee adopting a mere theoretical objection?—The gun went through a certain number of experiments; in early times, one of the Whitworth guns had burst, as we see in that Report of the year 1858.

5192. That was a cast-iron gun, was it not?—I believe it was.

5193. So far as the papers we have before us give us information, lead us to believe that only 91 experimental rounds were fired out of a Whitworth gun, and that out of a brass gun?—I have not seen any testing of the endurance of the gun; I have seen the great power of the gun against iron plates, and I admit that Mr. Whitworth did completely what he told me in early times he could do; that he could send a shell through a 4½-inch plate.

5194. But, with the exception of that very meagre experiment of 91 rounds originally made with a rifled brass howitzer, we have no detail of any further experiments made with the Whitworth gun?—No; and even now, a Committee has been specially appointed to compare the Whitworth and the Armstrong gun; that is, six months ago, but I do not believe that Mr. Whitworth has yet brought a gun to try.

5195. General *Peel.*] When the War Office applied to the Admiralty to know what description of guns and how many would be required for the next financial year, if you had ordered some of both guns they would have supplied them to you, would they not?—Yes, but I should not have taken the responsibility of ordering for the Navy a gun which had not passed the Ordnance Select Committee. I had an offer from Mr. Sidney Herbert in November 1860. I wrote to him to ask him whether we could not have a muzzle loading gun, and he wrote to me, that there were only three means of getting them. One was rifling and hooping the cast-iron guns. Then he said I must take the responsibility of blowing off the sailor's head. The next plan was to convert some of the Armstrong 100-pounders into muzzle loaders on the shunt principle; or that if I pleased I might order 200 Whitworth guns, but that that gun of Mr. Whitworth had never been proved and tested. Now, of course, I did not want to blow off the sailor's head with a cast-iron gun, nor did I, on the other hand, want to order 200 Whitworth guns which had not been tested.

5196. But you had power to order them and to test one of those guns as soon as possible?—Yes, we did test them.

5197. What was the result of that test?—The one which we had obtained after a great deal of communication with Mr. Whitworth burst at last.

5198. Even after that you did not think it right to take upon yourself the responsibility of ordering 200 of those guns?—Mr. Whitworth never had the right metal to make those guns.

5199. He never had any gun at all, had he?—Not except that gun which burst; never any large gun.

5200. Mr. *Vivian.*] Was that a cast-iron gun?—No, a wrought-iron gun.

5201. Mr. *Baring.*] A breech loader?—Yes.

5202. It failed on board the "Excellent"?—Yes.

5203. Mr. *Vivian.*] It burst in firing with depression?—It was very soon injured. I may say that I do not consider it a proper test of Mr. Whitworth's principle, because he never admitted that he had got the right metal.

5204. Sir *John Hay.*] Is it not the case that Mr. Whitworth has obtained his success, first of all, by tempering his shot and shell in a peculiarly advantageous manner; and secondly, by using a very much larger charge in proportion to the weight of the shot than that used by any other maker?—Yes; I think his great merit was his projectile. His shell was a very clever one; the hard substance of which he made it was his first great advantage; and the next was, that he could fire with a heavier charge.

5205. But

5205. But the effect of using a heavier charge has been the earlier destruction of his gun?—Just so.

5206. Colonel *Dunne.*] That was a shell, was it?—Yes; it did not produce so much effect when it got *through* the plate as we expected.

5207. Might not a gun be perfectly well adapted for batteries or field service, and yet not adapted for a vessel at all?—I suppose so, because you often want for field service a light gun.

5208. But supposing a gun was recommended by the Ordnance Select Committee for land service, would not it be tested on board the "Excellent," or in some other ship, to see whether it was adapted for sea service?—Yes.

5209. Between decks, has there been any gun approved of by the "Excellent" or the "Cambridge," or any of those vessels?—Yes; I think they very much approved of the 100-pounder.

5210. Was there not an objection to the smoke?—I am told that on board the "Excellent" they did not make that objection so much; from other vessels I have heard more of it.

5211. On board Captain Hewlett's ship, for instance?—They have made that an objection in the iron ships; the ports are very small, and there is less draught across the bulkheads, so that there is not so much ventilation.

5212. But that would be no objection in the field, or in a battery?—No. And again, I am not sure that the powder has not been altered. We have had a great deal of communication upon the subject of what was the right sort of powder, whether it was not too strong, and that led to the adoption of another kind of powder.

5213. And that kind of powder has been adopted and used in vessels?—Yes.

5214. And do you think the smoke is made thicker by that powder?—Yes; partly by that, and partly by the wadding, and sometimes they say by the lead coating.

5215. But your Grace has made no decision with respect to those objections?—No. All that we decided was, that when we found the 100-pounders had not so great power as we expected, we put fewer 100-pounders in the ships, expecting that they would only be used for chase-guns, and relying more on the 68-pounders.

5216. Is your Grace aware that in all these kinds of guns the initial velocity of the spherical shot is greater than in any rifled gun?—No, I do not admit that; I do not think it has been proved.

5217. But it has been asserted here?—It has been asserted here, and what is worse, I have asserted it in the House of Lords, but I was under a misapprehension. We have not yet arrived at half the knowledge that we shall in a short time have with respect to these guns.

5218. The whole science of gunnery is in a transition state, you think?—Yes; and so much in a transition state, that when I was this year asked what gun I approved of for the Navy, I was obliged to say that I really did not know.

5219. You think it is necessary for the country to go to a certain expense, in order to arrive at a solution of our difficulties?—I think we should have done nothing on the subject without these experiments.

5220. And you think that the experiments which have been made are well worth what they have cost the country?—Yes; I think they have been well worth their cost.

5221. Sir *John Hay.*] On the whole, is your Grace dissatisfied with the results obtained by the expenditure into which this Committee is inquiring?—I do not know the whole of the expenditure that the War Office have gone into, but I do not believe that they have done anything, except what was absolutely essential for the progress and improvement of our guns and iron plates. There has been no doubt an enormous expenditure, and I am afraid it must go on for a year or two, if we are to arrive at any satisfactory results.

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5222. *Chairman.*] But the expenditure your Grace alludes to as having been justified, was, I presume, expenditure made upon experiments?—I consider that the whole process has been experimental; I consider that the War Department and the Admiralty have been, during the last two years, experimental departments. We have, no doubt, been experimenting largely, but it cannot be helped. A large portion of the expenditure has been for experiments of one kind or another.

5223. But does your Grace think it was judicious to expend two millions and a half of money on experiments with one single gun, and hardly anything at all on other sorts of guns?—I have stated to the Committee, that before I came to the Admiralty I found a certain number of guns had been put aside as not being worth further experiments.

5224. Was Mr. Whitworth's gun one of those guns?—No; I think it was not put into that category.

5225. But, in fact, right or wrong, what has been done is to expend this enormous sum of money on one system of rifled guns, and hardly anything at all on any other system of rifled guns in the way of trying experiments?—A great amount has been expended upon that system, because it was necessary to put up very extensive machinery for the production of the guns.

5226. Sir *John Hay.*] Does your Grace think it would have been desirable, looking at the advances made by other European nations, to leave the whole question of guns for our army and our fleets in so unsatisfactory a condition, that if we had entered into a war there would have been no fixed gun on which the Government of this country could rely?—No, it would have been discreditable to the Government. During the years 1860–61, there were continual appeals made in the House of Commons by Sir Charles Napier and others, to know how many rifled guns we had got for our ships, and a continual pressure on the Government to supply rifled guns; if a war had broken out then, if the American war which threatened had really taken place, we should not have had a gun too many.

5227. You think it would not have been desirable to adopt a mixed system of guns, even if it had appeared that there were three or four systems of rifling which seemed almost of equal merit?—No, I think that would have been very unwise, and that the course taken was the best under the circumstances.

5228. And therefore, under the circumstances, the results of the expenditure are not to be blamed?—I think they are not to be blamed at all.

Lunæ, 6° die Julii, 1863.

MEMBERS PRESENT.

Mr. Baring.	Mr. Laird.
Mr. Beecroft.	Mr. Monsell.
Colonel Dunne.	General Peel.
Marquis of Hartington.	Sir Morton Peto.
Sir John Hay.	Sir Frederic Smith.
Captain Jervis.	Mr. Vivian.

THE RIGHT HON. WILLIAM MONSELL, IN THE CHAIR.

THOMAS GEORGE BARING, Esq., a Member of the Committee, examined.

T. G. Baring, Esq., M.P.

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5229. *Chairman.*] WILL you state to the Committee the dates at which you became Under Secretary for War, and ceased to be Under Secretary for War?—I became Under Secretary for War in January 1861, and left at the end of the Session of Parliament in the same year.

5230. What were the circumstances under which the estimate for Ordnance was framed in 1861?—The general circumstances at that time were, that the Armstrong gun had received, as a field gun, the very general approval of the officers of Artillery, and we had had reports (which the Committee has in the Appendix for last year at page 213) of the guns that were used for service in China, and which were considered exceedingly satisfactory. There were also other reports of those guns which had been tried against a martello tower on the coast, and also reports of the effects of exposure to weather upon the guns, which the Committee have in Appendix 46 of this year. All those reports were very satisfactory. With regard to the naval gun, the naval 40-pounders had been tried by Captain Jerningham, and the report, which also the Committee have before them, in Appendix No. 6 of this year, page 12, was satisfactory. With regard to any other gun at that time, I may say, speaking broadly, that the Secretary of State for War had no gun before him at all which could be put in competition with the Armstrong gun. There had been a great many trials of different systems of strengthening cast-iron guns, and there was also Mr. Whitworth's system of rifling. The position of the War Office with respect to Mr. Whitworth's gun, as distinguished from his system of rifling, was as follows, and that also is all before the Committee, that is to say, that in March 1860, the Ordnance Select Committee were directed to report as to Mr. Whitworth's and Sir William Armstrong's guns; that the Committee will find in the first Appendix this year, page 2. There was to have been at that time a competitive trial between certain guns which Mr. Whitworth had made and a gun of Sir William Armstrong's. In consequence of some difficulties with regard to the mode in which the competition should be carried out, Mr. Whitworth declining to abide by a certain part of the programme, that trial never took place; but instead of the trial a Committee was sent down to Southport to see the practice with those guns, and the Report of that Committee will be found in Appendix 43 of this year. The Committee will observe that Colonel St. George and Colonel Bingham signed this report, and there was also a naval officer there, Captain Herbert, I think. However, the main result of the report was that it was very favourable with respect to the range of those guns, and the Committee mentioned certain objections which they entertained to certain portions of the guns; they said, "Sufficient promise of advantage has been given to warrant the purchase of an 80-pounder and a 12-pounder; and we recommend that one of each of these guns be bought, and a series of experiments be made with them to ascertain their real value." In consequence of that report, Lord Herbert immediately bought two guns, an 80-pounder and a 12-pounder, both being breech-loading guns. At that time Mr. Whitworth had not constructed any muzzle-loading guns; all he had done was to rifle certain cast-iron guns.

5231. Mr. *Vivian.*] Those guns were equally used as muzzle-loading guns, were they not?—I was just going to allude to that.

5232. General *Peel.*] Can you tell the Committee the price of those guns?—The 80-pounder cost 1,000 *l.*, and the 12-pounder cost 170 *l.* The 80-pounder was tried at Portsmouth, and it ended by being damaged in such a way that it was not serviceable. I have here Captain Hewlett's Report in regard to the trial of this 80-pounder gun, which I can put in, if the Committee would wish to have it.

5233. *Chairman.*] Will you read the salient points of it?—The experiments with regard to that gun are also to be found reported in Appendix 28 of this year, page 29. Captain Hewlett's Report is as follows: "I beg herewith to forward a copy of the above experiments, and to state my opinion that the Whitworth system of loading at the breech, is not a desirable one, as it is very susceptible of injury, and requires more care in handling and using than it would be possible on service to give it." He then gives the details, and ends by saying, "With respect to its being constructed and used as a muzzle-loading gun, I am of opinion that it is very doubtful whether it could be used as a muzzle-loading gun, as it will require experiments to prove whether after being fired

fired a number of rounds, the projectiles could be forced home. We found at first that it requires no force, but after a few rounds, a hard deposit (notwithstanding the lubricating wads) formed in the bore, and although we used "the dry sponge on each occasion of loading, at the muzzle, we had latterly to use a wet one, and some force to get the projectile home." All that I wish to give the Committee to understand is this, that those guns, and the only guns that we had at that time made by Mr. Whitworth, as distinct from his system of rifling, had been bought by Lord Herbert, and that the trial was not such as to give him any very favourable opinion with respect to the gun, and certainly not such as to make it advisable to attempt to substitute that breech-loading gun for the service gun. I am aware that since that time Mr. Whitworth has not pursued that system of construction. The only other point, with regard to the position of the War Office, at that time, was the very important question of whether the cast-iron guns which we had in the service, could have been made available by strengthening and rifling them in the way that we understood the French had adopted. Lord Herbert took great interest in that question, and directed experiments to be made. The position of those experiments, at the end of the year 1860, was, that Mr. Bashley Britten's system was supposed to be by far the best introduced; guns rifled by him had stood 300 rounds without any danger, but the Admiralty, in the autumn of that year, wrote to the War Office, saying, most decidedly, after having perused the Report of the Ordnance Select Committee, that they were not of opinion that the gun could be introduced into the naval service with safety.

5234. *Chairman.*] Will you kindly put in that report?—This is a letter dated the 24th November 1860, which was just the time when the Estimates would be first brought under consideration. They say, "With reference to Captain Caffin's letter of the 22d instant, No. 73–3–1437 P, stating that the War Department could supply the Royal Navy in a short time with cast-iron guns, rifled and strengthened as the French, provided, like the French, they were fired with very light charges only, I am commanded by my Lords Commissioners of the Admiralty to acquaint you, for the information of Mr. Secretary Herbert, that after the Report of the Ordnance Select Committee, they consider it unadvisable to introduce into the service guns of this description, as in the event of any unfortunate accident occurring, the confidence which the seamen now have in the safety of their guns might be destroyed;" so that the Committee will see that at that time, speaking generally, there was no other gun before the War Office, which could be put at all in competition with the Armstrong gun, indeed I may say there was no gun at all. Therefore the Armstrong gun was the gun which was to be manufactured. The Committee have already heard from his Grace the Duke of Somerset, the requisition made by the Admiralty on the War Office for guns in February 1861. It was on that demand that the whole of the Estimates for the guns that year were framed. The Admiralty had been constantly pressing the War Office for guns previously to that time, and the reason why we could not deliver them was that experience showed the necessity of certain changes in the shape, size, and strength of the 40-pounders as compared with the 12-pounders, and therefore there was some delay in constructing the guns. Those were the circumstances under which the Estimates for 1861 were framed.

5235. What was the sum voted for Armstrong guns in that year?—In the year 1861, excluding the sum in the carriage department for carriages, and also the cost of powder, the sum voted was, in round numbers, 800,000*l.*

5236. What was the result of the expenditure?—The naval demand for the year was for 1,200 guns of different classes, and they also said that they would like to have 300 muzzle-loading guns, which made altogether 1,500 guns.

5237. Were those muzzle-loading guns to be Armstrong guns?—They were to be muzzle-loading guns; the Admiralty specified nothing more than that they should be rifled.

5238. Colonel *Dunne.*] Will you state the calibre separately?—The Admiralty asked for 200 100-pounders; 500 40-pounders; 250 25-pounders; 250 12-pounders; making 1,200 Armstrong breech-loading guns.

5239. At what date was that?—The demand was dated the 4th February 1861. We delivered of those guns, up to the 31st of March 1861 (which would be included in the financial year 1860–61), 185 of those guns. We delivered 60 100-pounders, 72 40-pounders, and 53 25-pounders. A balance therefore only remained to be delivered. To that balance we added 250 100-pounders which were intended to be used for fortifications, so that the provision which we had to make in the estimates for 1861–62 was to manufacture 1,057 Armstrong guns of different calibres. Money was taken for 300 muzzle-loaders besides, and also to finish a larger number of guns, some of which had been manufactured in the previous year. That was the basis of the estimate, and in order to meet that, we proposed to make 897 guns at Woolwich, and 940 guns at Elswick; the Woolwich guns were to cost 289,400*l.*, and the Elswick guns 199,500*l.* Those guns included the 300 muzzle-loaders.

5240. *Chairman.*] Where were the 300 muzzle loaders to be made?—We took 200 at Woolwich, and 100 at Elswick.

5241. Mr. *Beecroft.*] On whose principle were those guns to be constructed?—The principle was not determined upon. In August 1860, Mr. Whitworth was requested to make four muzzle-loaders, two to be made at Woolwich, and two to be made at Mr. Whitworth's own manufactory. Those guns had not been delivered at the time that the estimates were framed for 1861-62. The Committee know what took place afterwards with respect to those guns. One of the guns made at Manchester by Mr. Whitworth, with a steel barrel, failed in proof, and the other one was afterwards strengthened. The two guns that were made at Woolwich have afterwards been fired very successfully. Those guns may be generally stated as having been made on the coil system of construction. There is a letter before the Committee, which will be found in Appendix 23 of this year, in which Mr. Whitworth said, in May 1861, that he had not arrived at a sufficient certainty with regard to steel to enable him to make larger barrels of steel.

5242. Mr. *Vivian.*] Are those guns still in existence?—I believe that three of them are still in existence.

5243. And perfect?—I believe so, but I do not know. I believe that, in reality, those experiments

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riments lasted during the whole of the year 1861, and that the money taken, which was to be spent upon muzzle-loading guns, if such guns could be found fit for the service, was actually spent in making the larger calibres of Armstrong guns.

5244. *Chairman.*] Can you state how many of those guns were supplied before the end of the financial year?—Yes, I can state that. The number of guns delivered was 1,404 in all; so that the Committee will see that we expected to make 1,357 guns, and actually made 1,404 guns, the result being that the money produced a larger number of guns than it was supposed to cover. Of those guns that were delivered, 1,016 were delivered from Woolwich, and 388 from Elswick. The Elswick guns consisted of 184 110-pounders, 202 40-pounders, and two experimental guns.

5245. Mr. *Vivian.*] The additional guns came entirely from Woolwich?—The additional guns came entirely from Woolwich. The Elswick production was less than was anticipated, and the Woolwich production was considerably more. From Woolwich there were 495 100-pounders, and the smaller class of guns formed the remainder. There were 201 20-pounders, 254 12-pounders, and 66 9-pounders, making altogether 1,016.

5246. Can you state why Mr. Bashley Britten's system has not been tried with wrought-iron guns, as it was found to be best for cast-iron guns?—The course of experiments with Mr. Bashley Britten's gun was far from complete at that time, but I am not aware that at that time there was any proposal before the Secretary of State for War to try different systems of rifling with wrought-iron guns. As regards the expenditure for 1861–62, there was, as I think appears from the accounts, a small excess upon the vote for iron ordnance of 13,000 *l.*; the expenditure coming very nearly to the estimate.

5247. What was the estimated cost of the guns to be made at Woolwich and Elswick respectively?—The Secretary of State for War has to go on the estimates given to him by the head of the Royal Gun Factory, and the estimate given me by Mr. Anderson in 1861 was, for the 100-pounder, 500 *l.*; for the 25-pounder, 200 *l.*; and for the 12-pounder, 100 *l.*: and then there was for finishing each gun, 25 *l.* The whole of the finishing was done at Woolwich. The Elswick prices were taken, the 100-pounder at 600 *l.*; the 40-pounder at 285 *l.* The 100-pounder, in reality, cost more than 600 *l.*, namely, about 670 *l.*, nominally, 700 *l.*

5248. Mr. *Laird.*] You mean that that was the amount paid for it?—Yes.

5249. Was 670 *l.* the amount that the Elswick Ordnance Company charged for that gun?—I am giving the estimates. I had estimated for the 100-pounders 600 *l.* a piece at Elswick, but in reality they cost more than that, they cost 670 *l.*

5250. Mr. *Vivian.*] Was there not a previous bargain made with regard to the cost?—There was a contract made with regard to the 40-pounders, but the price for the 100-pounder and the price for some of the heavier description of guns, was provisional. So far as I can judge, the Elswick Company have behaved very fairly with regard to the price. They were ready to modify the price in the course of manufacture, if the guns came out cheaper than was expected.

5251. Captain *Jervis.*] With regard to that very price the superintendent of the Royal Gun Factory at Woolwich, declined almost to take that sum, did he not?—I do not recollect that. He would certainly have taken 700 *l.* or 670 *l.*, because he estimated the cost at 500 *l.*

5252. Mr. *Laird.*] Who was responsible for fixing and accepting those Elswick prices?—They were referred to the responsible officers at the heads of the departments at Woolwich, at which similar articles were made. For instance, in the case of projectiles, they were sent to the head of the Royal Laboratory, and in the case of guns they were sent to the assistant superintendent of the Royal Gun Factory, not to Sir William Armstrong, who had nothing to do with fixing the Elswick prices; those prices were all reported upon. Captain Caffin, I think, gave that in his evidence last year in answer to Question 2517. And on reference to pages 255 and 258 of the Appendix of last year, the Committee will see that the reports were made in every case by the responsible officers, and that the Secretary of State took their opinion with respect to the reasonableness of the prices.

5253. Then Sir William Armstrong did not interfere in those prices?—Not at all.

5254. Did he interfere with regard to the prices at Woolwich?—No, not at all. The accounts were entirely under the assistant-superintendent of the Royal Gun Factory; there was no Director of Ordnance at that time, but the Director of Stores, Captain Caffin, in communication with Sir Benjamin Hawes, had gone into the whole of the Estimates before I came to the War Office. I afterwards went over them very carefully with Captain Caffin and Sir Benjamin Hawes, and I also saw Mr. Anderson and Colonel Boxer upon the subject of the distribution of the vote between Elswick and the Royal Gun Factory.

5255. There was no competition of any kind, in order to ascertain the prices, but it was merely a question of opinion?—There was no competition; there could be no real competition with Elswick; they were, in fact, two Government manufactories.

5256. In fact, the Elswick Ordnance Company charged what they liked?—They charged what they liked, but we at the same time had the power of refusing or accepting those charges, and in the contract with the Elswick Ordnance Company, which was made by the Right Honourable and gallant officer on my right, there was a provision, that in the case of difference, we had a reference to the opinion of the Attorney General, whose decision was conclusive.

5257. A reference to the Attorney General with regard to prices?—Yes, with regard to prices.

5258. But virtually the prices were charged by the Elswick Ordnance Company at what they considered fair and reasonable, and the party who ought to have checked those prices was Sir William Armstrong, and upon all those matters he was not called in?—I should not agree in that view, and for this reason, that there were cases in which a charge was made and a deduction made from the prices. There were also cases in which in consequence of the price put on any article by the Elswick Ordnance Company, that article was made at Woolwich, and I do not think that Sir William Armstrong, in any part of his duties with respect to the War Office, had anything to do with the finance part of the question, he having only to carry out his invention; he would not have

have been able to give us the details of the cost of the gun at Woolwich.

5259. Sir *Frederic Smith.*] In fact, the War Office reduced some of the prices of the Elswick Ordnance Company, did they not?—Yes, they were in perpetual course of reduction, as the experimental stage of manufacture had ceased, and the real cost was known.

5260. Did they reduce their prices themselves sometimes, without reference to the War Office?—Yes; in the first instance, Sir William Armstrong recommended the Government not to make a contract with the company for the 12-pounder gun, and there certainly was a reduction in the price of the 40-pounders.

5261. Did the Elswick people agree fairly to that reduction, or did they argue and battle?—I have been looking back to what I stated in moving the Estimates for that year, and I find I said: "The practice of buying part of these guns from the Elswick Ordnance Factory, and of manufacturing others, had been found of great advantage, for it established a wholesome competition, and gave the Government some check as to the price. The Elswick Company had behaved with great fairness. The prices have necessarily been experimental at first, and, in one instance, they told the Government that the price which was being paid for a certain description of gun was too high, and voluntarily suggested a reduction. The original price of the 12-pounder was 250*l.*; it was now 120*l.* The price of the 40-pounder was at first 350*l.*, it had now been reduced to 285*l.*; and the cost of the ammunition was likewise being reduced." I said also (all this was said at the time, which is, perhaps, better than my saying it now), "the experimental character necessarily attaching to the manufacture of the guns has added largely to the expenditure. It might be supposed that when once a 12-pounder had been tested and proved, you had nothing to do but to make bigger guns on the same scale. But it was found that the same proportions would not answer for the 40-pounder; it was only by constant experiment that the proper proportions were arrived at, and nothing could be more interesting than the beautiful contrivances by which Sir William Armstrong had gradually overcome all those difficulties."

5261*. Mr. *Vivian.*] When you say that a wholesome check was established, was it the check of the Elswick Company on the Government factory, or the check of the Government factory on the Elswick Company; that is to say, was there ever a case in which the Government manufactory stated its costs as higher than that of the Elswick Company?—Yes, there was a case in 1862 in which the Elswick Company's rate for the 40-pounder was less than the Woolwich Estimate; you will find that at page 210 of the Appendix of last year (the Report of the Director of Ordnance with regard to the Estimates of 1862); and you will see that in giving the prices the Elswick Company quoted 285*l.* for the 40-pounder, and that the Royal Gun Factory price was 290*l.* Now I think myself that it is a great advantage having two establishments at work. Mr. Anderson said last year, that having other people engaged on the same work, and trying to see how cheap they could do it, was some encouragement to him to pursue the same course. I do not for a moment mean to say that the officers at the head of the Woolwich establishments, who are most anxious in every way to save the public money, would not have done their best under any circumstances, but still I think a little competition is a good thing.

5262. Sir *Frederic Smith.*] Was there any reason assigned why that price at the Royal Gun Factory was higher?—The reason was very evident, they had made no 40-pounders there.

5263. You mean that the price would be gradually reduced for the 40-pounders, as they made more of them?—They had made none at that time.

5264. Mr. *Vivian.*] Though you attribute the cheapening of the Government production to the fact of the existence of the Elswick Company, would not the same result have been arrived at supposing the Elswick Company had been absolutely a Government establishment, and supposing the country had had the benefit of the profit derived by those who worked the Elswick Company?—I think it very possible that two Government establishments might be advantageous, as competing one against the other; but looking at it broadly, however able our heads of factories may be, there is no doubt more inducement to exertion in a man being able to get a profit to himself.

5265. But in all cases you were paying more to the Elswick Ordnance Company than the guns cost at Woolwich, were you not?—Yes; no doubt, supposing the guns manufactured at the same cost, and with equal economy, in both cases, you must pay a profit in addition to a private company.

5266. To such an extent that, assuming that the Elswick Ordnance Company was not better managed than Woolwich, and that coal and other material were not cheaper, the guns could have been made at Woolwich for 242,000 *l.* less than they were made for at Elswick?—The Committee must not accept the return to which the Honourable Member is referring as a return of any value for the purposes of such a comparison as he is instituting.

5267. Mr. *Laird.*] You have stated that Mr. Anderson estimated 290 *l.* as the price of a certain gun. Can you mention what he charged?—He never made that gun. This was in the year 1862, when the Estimates were being considered, and in order to compare the prices he was asked to put down his figures, and those were compared with the tenders from the Elswick Company; he said that the 40-pounder would be 290 *l.*, while the price under the contract at Elswick was 285 *l.* The consequence was, I presume, that the gun was made at Elswick.

5268. *Chairman.*] Were there not a very large number of articles that were made exclusively, some at Woolwich, and some at Elswick?—After a certain time the whole of the 12-pounders were made at Woolwich.

5269. I see that the whole amount of the expenditure on Armstrong guns is about 2,500,000 *l.*, and I see in Appendix 44, that those items which can be compared amount to 593,000 *l.* and 351,000 *l.* respectively; to, in fact, nothing like the half of the whole amount?—No doubt; and the Committee will see that the 40-pounders are excluded from that return.

5270. But, speaking generally, that would be so?—Generally speaking, what we tried to do was to keep both factories working, each upon its own particular class of gun, and to give very large orders of the same kind to one, and very large orders of a different sort to another.

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5271. There was no competition in those cases?—There was competition to this extent, that there was an opportunity of comparing the relative cost of the different sorts of guns.

5272. Take the case of the Royal Laboratory. Do you conceive that the articles that are exclusively made there are not made as cheap and as well as those in which the Laboratory competed with the Elswick Company?—I never heard anything to lead me to suppose that the Royal Laboratory is not well and economically conducted. Colonel Boxer has taken as much pride in bringing out the articles as cheaply as any private manufacturer could do, and therefore I am not prepared to say that competition is necessary in his case, but generally it is a good thing.

5273. But still, I suppose a large amount of this expenditure was incurred on account of articles which were manufactured at Elswick, and which might have been manufactured at Woolwich?—If you refer to the amount for projectiles, I can give the way in which that was distributed for the year. The position of the manufacture of projectiles for the Armstrong guns from the first was that it was considered that while those projectiles were in an experimental stage, Sir William Armstrong should have the sole control of their manufacture, and therefore they were made to some extent in the gun factory at Woolwich, of which he was the chief. There were no projectiles made except some shot, I think, at the Royal Laboratory. While we were considering the Estimates for 1861, Colonel Boxer told the Secretary of State for War that as far as he could estimate he could make projectiles at a very much cheaper rate at the Royal Laboratory than they could be made at Elswick. That was considered, and I had frequent communications with Colonel Boxer, and was satisfied that in the main his calculation with regard to cost might be relied upon as to the money spent in the year, without reference to the real cost, which depends upon other calculations, and, consequently, we gave the larger portion of the projectiles for 1861 to the Royal Laboratory. We had no real prices from the Laboratory which we could compare at that time; we could only compare the estimates. I think it was 200,000 rounds that we gave to the Elswick Company, and 315,000 rounds to the Royal Laboratory, and the cost, the estimated cost at the Laboratory, which would be simply for wages and material, for the year, and contingent expenses, perhaps, was about the same; it was about 150,000 *l.* for the 200,000 rounds made at Elswick, and about the same sum for the 300,000 rounds made at Woolwich; that was the sum taken.

5274. Was there a larger sum or a smaller sum than the estimated sum paid during the course of the year out of the Treasury on account of costs of projectiles?—I have not got the accounts for Woolwich in such a way that I could answer the question. The money voted for the manufacturing departments is divided into two or three votes, and I have not seen it so separate as to make out clearly the return, especially as there was a supplemental estimate for stores in consequence of the "Trent" affair. In respect to the money paid to the Elswick Ordnance Company, the money was 10,000 *l.* more than the estimate, I think.

5275. Was that on account of a larger production, or was a larger sum paid for each article?—I was not there at the time, and I cannot answer for that small excess.

5276. Colonel *Dunne.*] Why was not the manufacturing of shells given to the Royal Laboratory?—It was because Lord Herbert wished Sir William Armstrong to have the entire control of the manufacture while the shells were in the experimental stage.

5277. General *Peel.*] That was one of the conditions on which Sir William Armstrong gave his patent to the Government, was it not?—It may be so, but I cannot state it from my own knowledge.

5278. Was the period which you mention now subsequent to the period of the second guarantee?—Yes.

5279. The original guarantee on account of projectiles was given by me for 10,000 *l.*, and afterwards Lord Herbert gave a guarantee for 20,000 *l.*?—Yes.

5280. Mr. *Laird.*] As Sir William Armstrong was the chief superintendent of the gun factory, could not he have given orders for the manufacture of those projectiles at Woolwich?—He had nothing to do with giving orders.

5281. But as he was the chief superintendent, could he not have those things made at Woolwich as well as at Elswick?—He was not the chief of the Laboratory, but of the Royal Gun Factory.

5282. *Chairman.*] He had nothing to say to the Elswick Ordnance Company?—No.

5283. Do you consider those prices given by the Elswick Company, to be excessive?—I have given the way in which the Secretary of State for War got at those prices. He could do nothing more than take advice of responsible officers. It is possible that they may have been all wrong, and that we may have been paying a larger price than we ought to have paid; but I do not think from the different reports, and the accounts of the prices, that such has been the case. Of course, in arriving at the price which can fairly be charged by a contractor, by comparison with the estimated cost, or the real cost of production, in a Government factory, there are many things to be added; there is insurance to be added to the price, and the Government do not insure.

5284. Mr. *Vivian.*] But you cannot burn an iron factory?—Then putting that on one side, there is still the profit to be added to the price paid to the contractor.

5285. Mr. *Beecroft.*] What would be, in your opinion, a fair profit to add?—I am told that about 10 per cent., or 12 per cent., is a fair mercantile profit, but I do not know.

5286. Mr. *Vivian.*] On the article manufactured?—I am told so, but I really do not know myself.

5287. Ten per cent. may be considered a fair return on capital, but that is turned over half a dozen times in the year, and if 10 per cent. were taken on the article, that would amount to 50 or 60 per cent. on the capital?—I do not profess to give an opinion as to what the profit ought to be, but the Elswick Company say 7½ per cent. is to be put down as profit.

5288. Mr. *Laird.*] And 5 per cent. interest in addition?—I would greatly prefer my answers should not be taken upon this subject.

5289. Mr. *Beecroft.*] Should not the profit be regulated in some measure by the amount of production?—I would prefer not going into that question, but I should say not.

5290. The

5290. The more frequently you turn your capital over the more you get?—No doubt.

5291. Sir *Frederic Smith.*] At Woolwich do you include the cost of the establishment?—I was going to give the reason why I do not think myself that the prices were excessive at Elswick. With regard to the 40-pounders, the price of 285 *l.* was very reasonable, I think. At Woolwich in 1862, Mr. Anderson put it down at 290 *l.*

5292. Mr. *Vivian.*] Mr. Anderson having at that time not made any 40-pounders?—He not having made any 40-pounders.

5293. And having no practical knowledge of what a 40-pounder would cost?—He must have known it within a few pounds, from his experience in making other guns.

5294. Mr. *Beecroft.*] Did he afterwards produce a gun of that kind?—No; I was stating that with regard to the 40-pounder, which was the gun of which the greatest number were made at Elswick, I did not think we had any reason to suppose that that was not a very fair price.

5295. Captain *Jervis.*] Supposing you to pay a manufacturer a higher price than the Royal Gun Factory price, you must take into consideration the fact that you pay him a certain price, because he has to make a certain quantity of work; when that is finished there is an end of his work. But the Royal Gun Factory goes on, and although when it is in full work, at first it works cheaper, you have to take into account the cost of keeping it up when there is no work to give out. Is not that to be taken into account with regard to whether you pay a contractor more than what you actually charge yourselves?—I do not think you can go much beyond this simple proposition, that if the manufacture by a private firm and the manufacture by the Government factory are equally economical, you have to pay the private firm a profit in addition.

5296. In this case during the three past years both the Elswick and the Woolwich factories were hard at work?—No doubt. I am satisfied that in 1861 no more of the large guns could have been made at Woolwich.

5297. To have made at Woolwich as many guns as you wanted you would have had to double the factory, would you not?—No, not to double it, because 380 guns were made at Elswick and 1,000 at Woolwich.

5298. But you would, at all events, have had very much to increase the Woolwich establishment?—To a considerable extent.

5299. The value of the Woolwich establishment was 300,000 *l.* when started, and, I suppose, it would have taken 200,000 *l.* more to make it capable of producing all that you required?—I should be sorry to give an opinion, but I think in case of any large addition to the number of guns produced, you would necessarily cheapen the production, and not have to spend anything like the same amount as you spent at first.

5300. Then taking a time like the present time, when very little production is required, you would have an enormous outlay laying idle?—No doubt, and we should have to add that to the price of the guns at the present time. I should like to add a word or two about the 100-pounders. I do not myself think, so far as I can judge, that the prices paid to the Elswick Ordnance Company for the 100-pounders were exorbitant or excessive prices. The Committee must see that this question of what the 100-pounder costs at Woolwich is in a very unsatisfactory state. Mr. Anderson, in his evidence, at Question 1362 of last year told us that he had calculated it himself "in half-a-dozen different "ways, and there is very nearly a difference of "100 *l.* between two of the ways;" a difference arising in adding one thing or deducting another, or distributing certain charges in one way or in another. I find that there are at least seven different costs of the 100-pounder given in the evidence and in the Appendix, and those costs I find differ to the extent of from 547 *l.* to 325 *l.* 19 *s.* 7½ *d.* It is very difficult to know what the cost of the gun to the country really is. I certainly am not prepared to say what the cost of the gun is at Woolwich at this moment, and it is just equally unsatisfactory when you come to the estimates. For so lately as the year 1862, in that statement which we had before us from the Director of Ordnance, it appears that Mr. Anderson put a price of 500 *l.* on the gun, while the estimates that we had before us for the 100-pounder (and estimates ought to be more uniform than prices) are eight in number, and vary from 325 *l.* to 500 *l.* Therefore, I say that with regard to the cost of the 100-pounder, we are altogether, at present, in an unsatisfactory state. And we cannot, either from the evidence or from the returns before us, at this moment, say what the cost of that gun has been.

5301. Mr. *Vivian.*] But there is this to be said, the price of the gun never much exceeds 547 *l.*; never amounts to 670 *l.*, for instance?—No; I was going on to add why I think that that price of 700 *l.* nominally, was not exorbitant; that price has to be diminished by about 30 *l.*, the value of the material which is stated in evidence by Mr. Rendell at Question 1827 of last year to have been returned by the Elswick Ordnance Company, so that the real price was 670 *l.* That price was upon 208 guns, and 208 guns ordered at a time when the guns were in the experimental stage; the very earliest orders of all. Every one knows how much more expensive the cost of an article is when in that stage, and also how much more expensive the cost of an article is, of that class, when you have only a limited number to make. The cost of 500 *l.*, estimated by Mr. Anderson in 1861, was upon a very large order for guns; they made no less than 490 100-pounder guns in that year; and in comparing the Elswick 670 *l.* for an early order, with whatever you please to take for that large order for Woolwich, a very great addition must be made to the price, in consequence of the first expense of manufacture; and to the Woolwich estimate of 500 *l.* (which, I think, I would sooner adhere to, considering that it has been given for two successive years), you have to add interest, depreciation, profit, and so forth.

5302. Depreciation is added, is it not?—Not in the estimate; the estimate is simply taken thus:—How many guns can you obtain for the money voted by Parliament? it does not include the cost of new machinery; it simply includes the wages, material, and contingencies.

5303. *Chairman.*] Let me refer you to Mr. Anderson's evidence, at question 1421 of last year:—"What number of guns on the average could you manufacture in your department?—Taking the 110-pounders, the 40-pounders, the 25-pounders, the 12-pounders, and the 9-pounders, I think we should be able to manufacture 30 per week."—By your statement it appears that during 1861, Mr. Anderson made about 20 guns per week?—Yes, that is so.

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5304. Therefore it appears to me that he could have manufactured the whole number of guns that were made at Elswick as well as those manufactured at Woolwich without spending any additional sum on machinery. Now if that be so, what elements would come into the calculation of the cost of those 437 additional guns, supposing they had been manufactured at Woolwich, except material and labour?—I heard that statement by Mr. Anderson; but the Committee will see, on looking to his answer at 1529 of last year's evidence, what he really meant to say. I am sure he did not wish to mislead the Committee. What he says at that answer is this: "I think we could make 30 guns a week. I could manufacture 10 100-pounders and 20 guns of smaller size." Now, in the first place, I can state (because I have made inquiries) that the men were working overtime both in 1861 and 1860, and if the Committee will look to the accounts of the manufacturing establishments they will see that there were 495 100-pounders delivered from Woolwich during the year 1861; and if Mr. Anderson could make 10 100-pounders a week the Committee will perceive that he could only have made 25 more, whereas 180 100-pounders were made at Elswick in that year. Therefore from my own recollection at the time, and from the knowledge that they were working overtime, and from what General Tulloh said in the Report for 1862, namely, that about 1,000 guns could be produced at Woolwich, I am prepared to say that the Woolwich factory was working at full power in 1861.

5305. But, supposing that to be so, the only additional charge that could fairly have been made to the manufacture of those additional 437 guns would have been the cost of the additional machinery that it was necessary to erect for the purpose of manufacturing them?—If the Honourable Member means to ask me whether it might not have been advisable to stop the manufacture at Elswick, and make the remaining guns at Woolwich during that year, I may observe that that question involves more than at first sight appears. The Committee is aware of the conditions under which the Government stood with the Elswick Company. We were under conditions with them that we should give them certain orders, enough to keep them going, otherwise they might come upon us for compensation, all of which has been fully explained to the Committee by the Honourable and Gallant General, with his reasons why he made that contract. In the year 1861 I stated that in the then condition of the Woolwich factory we could not have made (I never heard it stated that we could make) the guns that we ordered from Elswick; therefore the question we had to consider was whether we should very largely increase the Woolwich factory, and at the same time stop the Elswick factory and give them compensation; and I am prepared to say that that was a position which no minister would have taken at a time when we were wanting large supplies of guns.

5306. At that time, I suppose that the real facts of the question of difference of price had not come so prominently forward as they have done since?—All the facts of the question of difference of price had come prominently forward, with respect to projectiles; not with respect to guns, for the Woolwich accounts had not then brought out any cost of the guns.

5307. But there is no doubt that the Royal Laboratory could have made the projectiles; therefore, under those circumstances, why could not the whole of them have been ordered at Woolwich?—The Committee are aware that part of the capital of the Elswick Company was for the manufacture of projectiles; and also the Committee must remember that those prices on which we acted in 1861 for projectiles were estimated prices.

5308. But still we have had to pay the amount of compensation to the Elswick Company, so that we have had to pay not less, probably, than we should have had to pay at that time?—It never occurred to me personally that it would have been a wise course to close the Elswick factory when we were wanting guns.

5309. Captain *Jervis.*] Besides the question of enlarging the buildings at Woolwich?—Yes, we should have had to come to the House for compensation to the Elswick Company and for an increased vote for buildings at Woolwich, and no minister would have been prepared to make such a proposal.

5310. *Chairman.*] But according to Colonel Boxer's statement no additional machinery would have been required at Woolwich?—I have no recollection of his having made such a statement at the time.

5311. Colonel *Dunne.*] Can you mention the date of the gun on which the various Woolwich prices were founded?—In the year 1861 we had no accounts on which we could go, because the guns had not been long enough in existence for the production of an account.

5312. But I have never seen the elements of the nine estimates of the Woolwich 100-pounder gun?—The Honourable Member will find a very complete account of labour and material.

5313. But not of plant, and so on?—I think that the other part of the account is very susceptible of doubt, and very incomplete.

5314. Captain *Jervis.*] But when you were in office in 1861 was there anything to make you suppose that the guns could be made cheaper at Woolwich than at Elswick?—The only data which we had in 1861 were the estimates given by Mr. Anderson.

5315. Colonel *Dunne.*] Mr. Whiffin states, in Appendix 44, that if the guns had been made in the Royal Gun Factory, it would have saved a very large sum to the country; but then he takes the price for the guns made in the Woolwich Gun Factory, without furnishing any data to show that he is correct in that estimate?—I have had frequent correspondence with Mr. Whiffin, and have the very highest opinion of him as an accountant; I do not see very well how he could have given in the form of the return which he was asked to fill up, any report very different from this; but I have no doubt in my own mind that he would not wish the Committee to understand that so much money could have been saved. My belief is that that was not what he intended to convey.

5316. Mr. *Vivian.*] On what ground do you state that you believe he did not intend to convey that?—First, I will take the 110-pounders in this statement, No. 44. If it were intended as a comparison, taking into consideration all the different circumstances which are connected with each article, I cannot believe that the 700*l.* would be put down as the price, because the Committee have it in evidence that the price is 670*l.* Again, the construction of those guns was different in Woolwich and at Elswick. At Elswick the guns were made on the coil principle for the inner

inner barrel. At Woolwich the guns were at first made of wrought iron; the inner barrels were not of coils, they were made of forgings, and that, of course, would make an immense difference. Then, again, there were only 209 guns, made at Elswick, while at Woolwich, more than 500 guns were made, and in a comparison of that sort you must take into consideration the amount of the order. Then, again, looking to the 12-pounder guns, you will see that there were very few 12-pounder guns made at Elswick; and the date at which they were made was quite the beginning of the manufacture, when the guns were experimental, and the alterations were constant; against that is put the price which would be worked out for the Woolwich guns made upon very large order, extending over a very considerable time. Therefore those comparisons, even supposing that the rate put down here per gun as the cost at Woolwich is an accurate figure, depends on circumstances of which Mr. Whiffin was probably not cognizant; matters that were in the department of the Director of Ordnance, on the other side of the office.

5317. Mr. *Vivian.*] If you do not consider the manufacture of 209 guns sufficient to enable an establishment to manufacture cheaply, why should you consider the manufacture of 400 guns sufficient?—I would answer that in this way; I have no doubt that if an order for 400 guns had been given to Elswick they would have been able to have made them more cheaply.

5318. Mr. *Laird.*] Will you have the kindness to look at the Table, page 236 of last year's Appendix. You will see there columns headed cost of labour, cost of material, indirect expenses on direct labour, and so on, and then 7½ per cent. depreciation on buildings and machinery, and interest on capital; interest on capital 27 *l.* 0 *s.* 9 *d.*, bringing out the final cost per gun to 387 *l.* 10 *s.* 9 *d.*, which is compared with the higher price of 670 *l.* That is referred to in this calculation in Appendix 44, in which Mr. Whiffin does embrace, in addition to labour, material, and the per-centage on that, the amount of 7½ depreciation on buildings and machinery and interest on capital?—Yes, I see that; I was going to refer to the rate, but I should like now to state shortly that the question of the amount of the orders and the date of the orders; that is to say, the date being when the prices were so experimental, are elements which have not been taken into consideration in this comparison, and that, therefore, it cannot be relied upon. With respect to ammunition, the comparison is evidently incomplete in that respect. You take the whole of the prices paid from the very commencement to Elswick, and then you take the Woolwich prices for 1861–62, which was the first year when they took up that manufacture. They took it up, therefore, when the experimental stage was over; so that of course a comparison of their rates with the whole of the previous rates of the Elswick Company, could not be a comparison which would fairly justify the conclusion that you could have made the actual saving, which seems to be pointed at by the mere setting of one price against the other.

5319. Mr. *Vivian.*] Were not the experiments separately charged?—No; that was given in evidence last year. It is in evidence before the Committee, that the alterations in the projectiles would form part of the price.

5320. It is not the cost; it is an estimate, is it not?—This is a comparison, not of the estimated but of the actual cost; of the money paid by the Government to the Elswick Company for different projectiles, and thus the Committee will see that the early prices are very high, and the later ones lower; take, for instance, the 12-pounder shot at page 2, there are 234 12-pounder shots at 6 *s.* 3 *d.*; this is clearly a small number made for experimental purposes, that is, compared with the Royal Arsenal price for 1861–62, which is 1 *s.* 9½ *d.* But it will not do to assume, that if the 234 had been ordered at Woolwich at the time they were ordered at Elswick they could have been made for 1 *s.* 9 *d.*

5321. But take the very last order for 12-pounder shot, the Elswick price is 3 *s.* 4 *d.*, and the Woolwich price is 1 *s.* 9½ *d.*, there being nearly 100 per cent. difference?—I do not know when the shot ceased to be made at Elswick, but I think rather early in date.

5322. At all events, the cost at Elswick is 100 per cent. more than the cost at the Royal Arsenal, and the last Elswick delivery was 951 12-pounder shot?—I cannot say when those were delivered. I do not mean to say that there are not variations in the price; in some cases you will find that the Elswick prices, even compared with the Woolwich rates, as worked out in these columns are less, but you cannot compare in the main what are experimental prices with prices after that experimental stage is passed, and when the normal stage of expenditure has been reached.

5323. But does not it appear in the very last delivery from Elswick of 12-pounder shot, that 100 per cent. more has been charged at Elswick than at the Royal Arsenal?—If the Honourable Member will tell me the date of the delivery, I can answer the question.

5324. There are five deliveries in, probably, successive years?—It is an exceedingly small delivery of about 1,500 *l.*; the real large amount is, for segment shell; it is not a delivery of any importance in the comparison.

5325. *Chairman.*] How many shells do you suppose it would be necessary to make for the purpose of trying experiments, and arriving at a state of things in which the manufacture could go on cheaply?—That is a thing I can give no opinion on; all I can say is this: that there have been constant changes and alterations of pattern, which changes and alterations of pattern have increased the expense; and this is not an opinion of mine formed now in order to defend the War Office of that day, because I stated in 1861, on the voting of the Estimates, that we had then arrived at the time when the experimental stage was being got over.

5326. Mr. *Laird.*] We have had it in evidence that those changes have been constantly going on; therefore when an article went to the Royal Laboratory to be produced, it would have to go through the same changes, so that an experimental stage would have to be gone through in both cases; is that correct?—No; I think that in 1861 the manufacture was on a permanent footing. With regard to this comparison in price, the Committee perceive that the comparison is made between articles produced after the experimental stage, and articles produced during the experimental stage; besides that, there is a mass of questions with regard to the rates put down for the cost of the articles produced at Woolwich. The Honourable Member

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for Birkenhead asked me whether I had seen the Table at page 236 of last year's Appendix, which gives a rate of 387 *l.* 10 *s.* 9 *d.* for the 110-pounder guns. My answer is, that I have seen it, but I had nothing to do with preparing it, and cannot say how those amounts for depreciation were taken; but I see in the very same page a return which brings out 429 *l.* 13 *s.* 1 *d.*, as the price of the 100-pounder. Of course, Mr. Whiffin, in making this return, was obliged to take one price; he took 387 *l.* 10 *s.* 9 *d.*, not 429 *l.* 13 *s.* 1 *d.*, and he has put in the margin where the price was to be found.

5327. Colonel *Dunne.*] But then it is a question of comparison of prices?—I am not able to see any reason for taking one price rather than another; I should prefer taking Mr. Anderson's estimate for 1861 and 1862 of 500 *l.* as the nearest approach to the real price; therefore I think that no conclusion can be drawn from this return with respect to any such saving to the country as has been referred to.

5328. Mr. *Vivian.*] The difference between those two statements arises simply from the different modes of allotting the indirect expenses between different guns, does it not?—No, certainly not. The difference is, that the indirect expenses are allotted upon the whole of the produce of the factory in a different manner; in one case it is allotted upon labour, and in the other case it is allotted upon labour and material.

5329. But the difference is simply in the mode of allotting it between different guns?—No, not the mode of allotment between different guns, but between the whole of the produce of the factory. The effect of altering the calculation would be, that a less amount for the general expenses would be put on articles other than guns, and more on guns. I had paid some attention to this matter in 1861, and at that time we thought that, on the whole, the best way of allotting those general expenses was upon the labour employed. But when you come to work it out, and to see how it really comes out afterwards, you find that it is impossible to make such a rule. For my own satisfaction I worked out the sum with regard to guns. Nobody will deny that those general expenses should be in the same kind of proportion with regard to one gun as to another; if they were not to be precisely the same, the bigger gun, which requires the largest quantity of plant, and so on, and consequently the greatest amount of contingent charges, should have the largest amount of contingent expenses allotted to it. Now, if in the return, given in Appendix 4 of last year, you take the per-centage of the general expenses, and the interest, upon the total assumed cost of each gun, you will find that it is 30 per cent. on one class of guns and 17 per cent. on another; and that the highest rate was charged upon the smallest gun; that showed me at once that a division of that kind brings out such a variation that it cannot be right.

5330. Captain *Jervis.*] Is it part of your proposal that a portion of the expenditure should be allotted on all kinds of labour?—Yes.

5331. I find on page 30 of the Army Return (176) of this year, this charge: "A competent person to be sent to Wellington Barracks, to inspect a boiler;" and his labour is charged at 18 *s.* 10½ *d.* How would you apply the 40 per cent. upon things of that kind?—Supposing that you were to carry the thing out, and to add to that item its proportion of interest and depreciation, it would be reduced to an absurdity. But I do not think there is any great importance to be attached to those small things.

5332. Except with regard to the question of principle?—Except as a matter of principle. Mr. Anderson had the same opinion at first, namely, that it was better to make the distribution over the labour. But Mr. Anderson saw, when he was examined here, the same obstacle as every one sees, how difficult it is to get to the real cost of an article in that way. He said he thought that no two people would agree upon it; and I do not believe that they would. But he stated, in answer to Question 1450, "I think, in going fully into it, that it should be on the whole value of the gun; that is to say, labour and material." But even if you put it on labour and material, you arrive at a very unsatisfactory result.

5333. Colonel *Dunne.*] How is that done in private manufactories?—I expect that they put a per-centage on certain articles.

5334. The Organization Committee went very fully into this question, and all those difficulties were examined with Mr. Anderson and two or three clerks of the highest class in the War Department, and in consequence of that I think these attempts were made?—Yes; in the first place, in consequence of the report of that Committee; and secondly, in consequence of considerable discussions in Parliament on other matters; for instance, the cost of the muskets made in the Government manufactory at Enfield, and the cost of the clothing made in the Government establishments, a question frequently brought forward by the Right Honourable Chairman of this Committee.

5335. I have always stated that the Government never knew the price of anything, and I believe it still, and you are no doubt aware that others are of the same opinion?—I believe the general impression of the public was, that we had no Government accounts which would really give the prices of articles. The officers at the head of the different factories at Woolwich and at Enfield did not receive justice in the argument, because there was not the slightest doubt that the accounts of the smaller arms Factory at Enfield, and the Woolwich Factories Department too, I believe, were kept in the most minute detail; all that was wanted was to bring these together and work out the cost. That was the reason why this thing was gone into, and this return of the annual accounts of the several manufactory Establishments which has been laid before Parliament, is the first attempt to obtain a proper balance-sheet, and to arrive at the real cost. What was tried to be shown was the real cost to the country of each article produced, and I think that this is a very great step forward, though the thing is very far from complete.

5336. *Chairman.*] Take the case of Enfield. The country spends there a certain sum of money every year, and obtains a certain number of guns. Under those circumstances, you can infallibly tell what each gun cost; that is to say, if you pay 300,000 *l.* and get a certain number of guns, and divide one by the other, the result is exactly what the gun cost the country. Is not that so?—I should say that would give you only what the gun costs for the year, but not what the gun really costs the country.

5337. But in the case of the Royal Laboratory, I think that Colonel Boxer stated that he keeps an account of all projectiles which he makes, and

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other articles for the Armstrong gun, entirely separate from all his other accounts. Under those circumstances, cannot you with absolute certainty determine what the projectiles cost the country, assuming that the accounts are kept quite distinct?—It is very difficult to discuss that question without taking a particular case. Here is No. 2 Account for the Royal Gun Factories. The first thing I can see is, that there is a very large amount of stock in the hands of the Government. For instance, in the gun factories at the beginning of 1861, we had 180,000 *l.* worth of either stores or semi-manufactured articles in hand, and at the end of the year we had 117,420 *l.* worth. Now the Committee will see that in that year there is, beside the sum voted by Parliament, an expenditure of 63,500 *l.*, consisting of a dimunition of the stores, &c., in the stock at end compared with the beginning of the year. Now, unless the sum with which you credit yourself at the end of the year in the real value of those stores, &c., the whole of this account may be worth nothing. If, for instance, this is not the value of the stock in hand at the time that the balance-sheet was made, if it was only the cost price, it may be really worth only 50,000 *l.* instead of 100,000 *l.*, and the difference ought to have come out in the cost of the articles.

5338. Mr. *Vivian.*] That same case occurs in every private establishment, does it not?—No doubt.

5339. The best system on which private establishments are conducted is this, is it not, that a certain permanent stock is fixed upon as the regular standing stock, and that is invariably taken at the same price, with regard to each item?—It would require considerable discussion among those who, like the Honourable Gentleman, are acquainted with the way in which private establishments are conducted, to get at the correct principle on which to make out the account.

5340. The difficulty is one which is encountered by every firm in the kingdom?—No doubt.

The next thing which the Committee see in this balance-sheet is capital account for new buildings and new machines; that sum is money spent in the year. There are two ways of dealing with that; one is to divide it over the articles produced in the year, and the other is to have a depreciation account, and to charge depreciation year by year. I think the latter way is the best way, because if you divide it you arrive at a fictitious price. I think, therefore, the depreciation should enter into the cost of the articles, whatever you do with regard to interest, because it is part of the actual positive cost.

The next thing is the production account; and a remarkable thing in the Gun Factory return is the division of this production account. The Committee will see that they have very properly calculated it in two different ways; first, by distributing the general expenses on labour alone, and then on labour and material combined. The result is, that nearly one half, that is to say, 203,562 *l.* of the whole produce of the Gun Factory in the year consists of articles other than Armstrong guns. That is a very remarkable result from this account, because, when we made the estimate, the sum put down was very much less. There was 47,625 *l.* only taken for this miscellaneous production, part of which was for finishing Armstrong guns, and the rest for the other work; and when I look to the list of miscellaneous production in the Gun Factory, I see there is a deficiency. What we want is, to have a list of the articles produced, and what each article is priced at, and this, I believe, is done in the carriage department and in the laboratory accounts. We said a detailed list of stores should be given, showing the number passed into store, the number on hand, and the rates, and so on. With respect to the price put on those articles in fact, we want more information. I have no doubt that the Secretary of State for War will direct in any future accounts that we should have more minute details with regard to the price. The Committee will see, supposing the price is heavy (I do not say it is), we may come to this result: that we may be paying too much for one thing and too little for another, so that until this sum is worked out in each article to the price, we cannot come to any satisfactory conclusion with respect to the price.

5341. Colonel *Dunne.*] Several of these items must be obviously wrong; for instance, on page 22, the charge made for sighting and browning 1,562 Armstrong guns would come out at 40 *l.* a gun?—I should like to hear what the Superintendent of the Gun Factory had to say on that subject, before answering any question about it.

5342. But do you think we can depend on the prices exactly as they are put down here as being the exact cost to the country?—I think not; if that were 40 *l.* a gun it would be considerably in excess of what we estimated it at, namely, 25 *l.* at the beginning of the year. I have no doubt there are reasons for it. I think there is no doubt that this list of miscellaneous work done would require on the part of the Accountant-General's Department at the War Office very great attention, and I have no doubt it will receive that attention. Many of those charges which are put down as work produced, ought, I think, to be really part of the general expenses.

In continuing my remarks on this balance-sheet, I come to the other question which affects the price of everything, namely, how the general expenses are to be levied: a question which requires to be authoritatively settled.

5343. Sir *Frederick Smith*] Does the same plan exist at all the establishments?—No, some do it one way and others another way; indeed, I do not think it is possible to have it the same in all cases. Then the next thing is the depreciation and interest. I do not think that we have yet any general accounts as to what the capital of the gun factory is.

5344. Captain *Jervis.*] Is anything known with respect to the actual cost of the Gun Factory?—That is in a very unsatisfactory state; it is estimated at 200,000 *l.*, but Mr. Anderson said in his evidence that he did not expect any such manufactory could set up for that. I think we want, in order to come to a conclusion with regard to depreciation, to have something like an inquiry with regard to that subject. There is another matter which is entirely omitted, which is, the general expenditure on the Arsenal at Woolwich, part of which ought to be added to the Gun Factory, such as roads and wharves, and so on, on which depreciation must be charged, the same as on other things. A road may be useful one year, and perfectly useless the next. Then, also, if you want to come strictly at the real cost to the public, you have to consider the value of the land. That would bring me to the question of interest; depreciation must be inevitably included in the account, because you have

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have actually to pay money for machinery, but the interest is on another principle.

5345. *Chairman.*] Take the case of the roads; supposing that the whole of these articles had been made at Woolwich, you would not have had to pay anything more for the roads than you now pay, would you?—I cannot say without seeing the plans for enlarging the factories.

5346. But taking gas and other things, the additional amount would have been very small, would it not?—No doubt; as in all wholesale dealings, the more you increase your business the more cheaply you do it.

5347. Mr. *Laird.*] If the 85,000 *l.* spent at Elswick on machinery had been spent at Woolwich, you would have had the machinery, and you would have saved 10 per cent. depreciation charge year by year, would you not?—I think that that question never could have arisen during a year of large production at all.

5348. We have paid, according to Earl de Grey's evidence, 85,000 *l.* to the Elswick Company, 65,000 *l.* for depreciation of plant, and in a further account they charge 10 per cent. for depreciation of plant. Now the works have amounted to a million of money, and there must have been nearly 100,000 *l.* written off in depreciation of plant, which virtually has been charged to the Government in their prices, has it not?—I am not aware of that; the depreciation would not be on the orders but on the capital, I think.

5349. According to the account put in the 10 per cent. depreciation is on the works?—That is a matter with regard to which I do not think I should express any opinion, because my opinion is of no more value than that of any other Member of the Committee, if of so much.

5350. But there is an establishment at Woolwich upon which a large sum of money has been spent?—Yes.

5351. And unless you are prepared to sell the property, it is of no use taking into consideration the depreciation on money spent before this time?—I think with regard to depreciation, that it is absolutely necessary to take it for any one year. In this year it was 22,222 *l.* 13 *s.* 8 *d.*, spent on buildings. That money was spent on buildings made for the purpose of manufacturing the articles made at the Royal Gun Factory; if you take no account of that money you do not even produce a return of the cost of the articles for the year; you can either divide the whole of the money, year by year, among the articles produced, or you may charge depreciation. The latter plan seems to me very much the fairer. Take the year 1859 in which you spent 68,000 *l.* in machinery, &c., for the factory, that machinery will, before 30 years are over, be utterly useless, probably. It would be the result of extraordinary foresight if it were of any use 30 years hence.

5352. But are you required to get at the value of the establishment as it now exists, unless you are prepared to sell the works as they now exist?—Certainly; all that must come out of the taxes.

5353. *Chairman.*] Is there any further remark you wish to make upon this subject?—It appears to me that the amount of capital on which interest is to be charged, has not yet been completely settled. With regard to the interest, it is, you may say, a fictitious charge. It is, however, a charge to the public, no doubt, because if you did not require these large amounts of stores in a Government factory, you might sell them and pay off the debt to that amount; that would be a course which it would be competent for any Goverment to take, and a course which a Government probably would take, if they were going to give up the arsenal altogether. Now these amounts, as given in these accounts, are very large. Therefore, if you have to work out the real charge to the public, it is quite fair and right to consider what amount of capital you have embarked in the shape of public money, and to charge a low rate of interest upon it, say 3½ per cent., or whatever may be the rate of interest at that time.

5354. Mr. *Vivian.*] As far as any of these amounts of capital have in any case been ascertained, it appears that the depreciation on buildings and machinery, and interest on capital are charged on the whole; is it not so?—I am not quite certain with respect to the minor accounts. In the annual balance sheet, no interest on capital is charged, I think.

5355. Repairs of buildings are charged on the debtor side of the account, are they not?—Yes.

5356. But if repairs are charged, depreciations ought not to be charged; is not that so?—It depends on what the repairs are. In this balance-sheet there is no calculation with respect to the capital on which interest is to be charged. But it is my opinion that if you wish to arrive at the right cost to the public, interest should either be put down, so that anybody who looks at the account can add it, or else that the interest should be charged. Of course it signifies very little that a thing is omitted if you know what it is. But I think something should be done in order to show what the capital employed in, say, the Royal Gun Factory, really is. Mr. Anderson has made calculations upon that subject, but I think it requires to be definitely settled at the War Department, in order that we should know what the amount of capital employed is. Of course it will include, first, the sum on which depreciation is charged for the value of buildings and machinery; secondly, the stores in stock and the semi-manufactured article; and, thirdly, there would be the value of that portion of the works on which depreciation also would be charged, such as roads and wharves. There would also be the value of the land, if you please to include that; and there is another item which would be a matter of question, namely, the sum of money which you must have at your bankers to pay the men's wages, which, of course, is very considerable.

5357. Mr. *Beecroft.*] Do not the prices given as the cost of manufacture at Woolwich, include all experimental expenses and the additional cost arising out of any new manufacture?—I should say, certainly not, because certain experimental expenses, all, I believe, included in the miscellaneous charges. Therefore I should say with respect to the prices of guns that that is not so. I cannot, however, state this with certainty.

5358. Captain *Jervis.*] If shells were made at the Woolwich Laboratory for the purpose of experiments, would not the cost be charged with that of the shells for the service?—I do not know.

5359. Colonel *Dunne.*] Do you not think it ought?—I think it depends upon whether they are experiments to carry out an order of the War Office, or whether they are experiments for the purpose of completing any ordinary manufacture. If there were experiments made for the satisfaction of the superintendent, previously to the

the completion of an order, I think they ought to be charged to that order.

5360. Mr. *Beecroft.*] You have spoken about being pressed to make the guns. Suppose you had carried on the work night and day at Woolwich, could you not have produced nearly double the quantity?—I should be sorry to say that I thought so. My impression is, that in 1861 no more 100-pounders could have been produced.

5361. Captain *Jervis.*] In certain portions of the Royal Gun Factory they were working night and day, were they not?—I think they were.

5362. Mr. *Beecroft.*] Then you do not think that if the machinery had been working night and day, a larger quantity could have been produced?—I believe a large number of the smaller guns might have been produced in 1861, but not of the larger guns. Mr. Anderson states in his evidence that he could have produced 10 100-pounders a week, and there were actually 495 delivered in the year, and that leaves a very small margin for further production.

5363. Mr. *Vivian.*] May not the difference arise between what the Gun Factory is now capable of producing, and what it was capable of producing in 1861?—Yes; certainly.

5364. Now, to return to the subject of depreciation; do you not think depreciation ought only to be charged in relation to the original cost of buildings and machinery?—I should say so, or you might carry it still further, and when you make any great change in the Government factory, you might take an estimate of the actual value.

5365. But still it ought to proceed, ought it not, to some extent, on the original cost of the buildings and machinery?—Certainly.

5366. But in these statements which have been given to us, it appears that the depreciation on buildings and machinery, and interest on buildings and capital, proceed not on that basis, but upon a certain per-centage charged upon the work done?—I should have thought not; I am not prepared to say how these numerous returns of the cost of the 100-pounder have been formed; the only thing I can look at is the actual balance sheet of the Gun Factory; and here I see the account is given at page 36 of the manufacturing account, which shows how the depreciation is charged. It takes the capital, buildings, and machinery given at page 239 of the Report of the Select Committee on Ordnance of last year, and charges 5 per cent. on buildings, and 10 per cent. on machinery, amounting together to 19,074*l.* 17*s.* 8*d.*; so that that would be taken on the actual value of the buildings and machinery, and not upon any arbitrary per-centage upon the articles.

5367. Then this account would be carried on so that eventually it would be extinguished, would it not?—If you assume that no additions to the machinery are made, but that is not the case.

5368. The amount would be extinguished in the course of years, assuming the existence of such a state of things as existed from the time of Queen Anne down to the present time?—If you assume that no machinery is added equal to the annual depreciation.

5369. It appears that this year the result of so charging it was to write off the exact amount, or nearly so, of the new machinery added?—Yes, but this year would be a very bad instance to take, because this is a year succeeding a year of very large expenditure; but even this year 22,252*l.* 13*s.* 8*d.* was spent upon new buildings and machinery, and the depreciation charge is 19,000*l.* odd.

5370. But the country had the advantage of the 22,000*l.* expended?—No doubt.

5371. The amount of the expenditure of the year was nearly written off in depreciation?—No doubt.

5372. It has been given in evidence, that a portion of the charge with which the Elswick Company had debited themselves in order to ascertain the cost of their guns was a depreciation of 10 per cent. Now, supposing that the Elswick Company had been a public factory instead of a private company, and that the depreciation had run over the number of years for which that factory had existed, would not that so far have lessened the capital as to reduce it to a comparatively small amount at this moment?—That would depend on the additions that were made year by year.

5373. But take the guaranteed capital?—I apprehend that the depreciation was charged on much more than the guaranteed capital; much more than the guaranteed capital was used by the Elswick Company.

5374. But still the country would have had the benefit of that depreciation of capital, would it not?—No doubt it may be said that it would have been more advisable in the first instance to make Elswick a Government factory, and if that had been done no doubt it would have been as the Honourable Member says; but that question, whether that should be done or not, depended on other circumstances, which the Right Honourable and Gallant General has explained to the Committee in his evidence.

5375. But, on the other hand, the country would have benefited also by a larger divisor for the reduction of their standing charges; that is to say, more guns would have been made at the public factory, while the standing charges would have remained substantially the same?—I do not believe you would in that case have made the guns cheaper.

5376. But there are certain standing charges, such as salaries, police, and various other general charges, which apply whether a larger number or a smaller number of guns are made?—No doubt.

5377. Now, supposing the whole of the guns had been made at Woolwich, and supposing Woolwich had been laid out at first on such a scale as to meet the requirements of the country, would not the cost of the whole production have been reduced to the extent of those standing charges?—No doubt it is true that, assuming that it was possible at that time to start Woolwich on a much larger scale, you would have come with respect to each gun to a lower price.

5378. In those estimates which have been given us of the cost of the items, the amount of indirect expenses charged on labour and material amounts in the lower of the two statements, to be found on page 236 of the Appendix of last year, to 58,000*l.*?—Yes.

5379. That being for 1861?—For 1860 it was 63,000*l.*; 58,000 was for 1862.

5380. These indirect expenses apply to the labour expended in the whole of the Royal Gun Factories, do they not?—I am not prepared to explain those figures, because I did not make up the accounts, but what I understand from them is, that supposing the indirect expenses to be, as I believe they were, 63,000*l.* odd, and that any other sum you please was expended in the year

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year upon wages and upon material; then having arived at the amount of the wages and material on any particular article, this column shows the proportion of the general charges which should be applied to it. That is to say, if the general charges are divided among the separate articles in proportion to the amount of the material and labour together.

5381. What is given here does not represent the whole of the items that were charged with those indirect expenses?—No; it would be about half, I think.

5382. Then supposing these indirect expenses do not, to a large extent, correspond with the amount of the guns manufactured?—I should be very sorry to say that; there is another thing which requires looking into. These indirect expenses are very considerable. For instance, Mr. Anderson stated that anything like serious repair, such as the breaking down of a boiler, would be put down to indirect expenses. I am not prepared to say that there would not be a very large increase if you increased the plant.

5383. The question is, to what extent shall the guns be debited, and to what extent shall other articles be debited with indirect expenses?—That is not a very large point, but it is also to be considered to what extent should each particular class of gun be charged. On the 6-pounders the indirect expenses on direct labour are 987 *l.* 14 *s.* 9 *d.*, and the indirect expenses on labour and material 637 *l.* 1 *s.* 10 *d.*; so that in the 6-pounders you have less distributed on labour and material than on labour. On the other hand, the 110-pounder, if you take it with the indirect expenses on labour only, comes to 360 *l.* 10 *s.*, while if you take it with the indirect expenses on labour and material combined, it comes to 395 *l.* 0 *s.* 6 *d.*, so that the reverse is the case with the two guns.

5384. But the other articles manufactured on account of the country would have the benefit of the 35 *l.* difference being brought to their credit in the debiting of the 110-pounder with the additional sum for labour?—Yes, but at the same time that that is cheaper, the rest of the articles come out dearer, or *vice versâ*.

5385. So that the country has the benefit of the cheapening of the 110-pounder?—The articles may benefit, but the country spends the same. It can only have what is produced for its money. The country can get no advantage by calling the gun 500 *l.* and the other article 200 *l.* You must of course divide the whole expenditure between the articles, but what we want is to get at the correct way of doing it.

5386. No doubt that is so, but the meaning of my question was this, that the other articles manufactured would apparently come out cheaper, and to that extent, supposing some articles to be manufactured at Woolwich and some articles by contractors, it would appear that the Government was making the article at a cheaper rate?—Certainly.

5387. Supposing that it had been the case at Elswick, the country would not have had the benefit of that lowering of the cost of the other articles, would it?—But I apprehend that Elswick made nothing but guns.

5388. But let it be supposed that more guns had been made in the Royal Arsenal?—If more guns had been made in the Royal Arsenal, the price of the guns would have been a little less, I presume.

5389. Mr. *Laird.*] To return for a moment to the question, how much was written off by the Elswick Company for depreciation, in reply to my suggestion that the 10 per cent. was written off on the amount of the orders, you stated that it would be on the amount of the plant?—Yes.

5390. If you will turn to page 152 of last year's Report, and look at the Table headed "Estimate of the Cost of Production of the 110-pounder Breech-loading Armstrong Gun," you will find that the 10 per cent., 37 *l.* 13 *s.*, is 10 per cent. on 396 *l.*, or on the cost of the gun?—As I read it, it is 10 per cent. on the plant, but I cannot explain the accounts of the Elswick Ordnance Company.

5391. Does it not appear from that account that the per-centage for depreciation is not charged on the guaranteed amount, but on the cost of the gun up to that point?—Of course. I cannot discuss the Elswick Company's prices, but in this list I see the words "depreciation on plant."

5392. If you will add up the first four items in the left-hand column in that Table, you will find that they amount to 396 *l.* 6 *s.*, which is the cost of the gun?—But 10 per cent. on 396 *l.* is not 37 *l.* 13 *s.*, and it is stated in this return that it is 10 per cent on plant.

5393. You will find that it is within a trifle of 10 per cent. on the cost of the gun?—But it is not exactly 10 per cent. on the cost of the gun. It appears to me generally that this account is formed upon correct principles, depreciation being charged upon plant and interest upon capital.

5394. General *Peel.*] The Secretary of State for War, in moving for the Estimates for the present year, said, did he not, that in consequence of the experiments that were going on, it was intended to suspend the manufacture of the Armstrong guns, and that he had only taken 5,000 *l.* for the present year, for the production of those guns at the Royal Arsenal?—I believe so.

5395. If the whole of the depreciation on machinery and all incidental expenses are to be charged on that limited number of guns, it would make the cost of those guns much larger than they ever were in any former year, would it not?—Supposing the production in the Royal Gun Factory to be from any cause very largely reduced, it would come out in an increased price for the article.

5396. Therefore, when you ordered at Woolwich, in the year 1861–2, twice the number of guns that you ordered at Elswick, that would naturally reduce the amount of those extra charges on the guns made at Woolwich, in comparison with those made at Elswick?—No doubt if Woolwich was working at its full power, and Elswick at less than its full power (and Elswick was working at less than its full power in 1861, because we received a letter from the Elswick Company, saying that they could make very many more guns and projectiles than they were making), that would tend rather to swell the incidence of the general charges and depreciation. The apportionment of those charges would be very simple; it being merely to divide it among the number of guns made.

5397. Colonel *Dunne.*] Do you recollect that the time the Armstrong gun was selected for the service, there were experiments made between a 68-pounder, and the Armstrong gun, against martello towers?—Yes, in the autumn of 1861, against a martello tower, not long before I was at the War Office, and the result was considered

sidered very satisfactory with respect to the Armstrong gun.

5398. General *Peel.*] At a thousand yards, was it not?—This is the account that I received in the spring of 1861: "In order to determine the efficiency of the Armstrong gun for breaching purposes as compared with the old service guns, it was decided to try the effect of each against two of the martello towers on the Sussex coast. The two towers selected for this purpose were exact duplicates of each other, and were each intended to be pulled down as the sea was rapidly undermining them. One of these was assigned to the Armstrong gun, and the other to the common guns, the distance in each case between the guns and the tower being 1,032 yards. The Armstrong guns used on the occasion were one 40-pounder, weighing 31 cwt., one 80-pounder, weighing 63 cwt., one 100-pounder howitzer, weighing 53 cwt. The common guns consisted of two 32-pounders, weighing 58 cwt. each, two 68-pounders, weighing 95 cwt. each." He then goes on to mention what number of rounds was fired with each. "It will be seen, therefore, that the weight of the guns and the quantity of ammunition expended was very much greater in the case of the common guns than in that of the Armstrong gun; but the result was, that while the Armstrong guns completely demolished the tower on the side exposed to their fire, the others did not even effect a breach by which the tower could have been entered." And I had a photograph showing the effect of the gun, which was sent to Prince Albert at the time.

5399. Mr. *Vivian.*] To recur to the subject of depreciation, you will find at page 152 in the Appendix of last year, that the amount charged by the Elswick Company for depreciation is 37 *l.* 13 *s.* on 396 *l.*, which, as stated by the Honourable Member for Birkenhead, is about the addition of the four first amounts; that is about 9½ per cent. on the cost of the gun, is it not?—I have not checked those figures; I do not profess at all to understand the Elswick accounts; all I say is, that if this printed paper is to be believed, depreciation is charged on plant and interest on capital.

5400. But the amount charged is 9½ per cent. on the cost of the gun, is it not?—Very possibly.

5401. So that if 9½ per cent. is charged on the amount paid to the Elswick Company, it is perfectly clear that the whole of the capital guaranteed by the country would have been written off with about 15,000 *l.* to the profit of the country, if the 9½ per cent. depreciation had been continually charged; is not that so?—I do not profess to speak from any personal knowledge of the matter. It is clear that this question of depreciation was considered by the arbitrators who determined the amount of the compensation.

5402. *Chairman.*] Is there any further remark which you wish to make to the Committee?—I only desire to say that I wish the Committee to understand that, in discussing these manufacturing accounts, I do not wish to throw any blame upon those who have framed them. They are in a condition of progress. Mr. Anderson has stated that he did not think that we had come to any clear principle upon the subject. Great pains have been taken with the accounts, and I do not wish to throw the slightest blame on any one in relation to them.

Jovis, 9° die Julii, 1863.

MEMBERS PRESENT.

Mr. Baring.	Captain Jervis.
Mr. Beecroft.	Mr. Laird.
Mr. Dodson.	Mr. Monsell.
Colonel Dunne.	Sir Morton Peto.
Marquis of Hartington.	General Peel.
Sir John Hay.	Sir Frederic Smith.

THE RIGHT HON. WILLIAM MONSELL, IN THE CHAIR.

Captain ALEXANDER THEOPHILUS BLAKELY, called in again; and further Examined.

Capt. *A. T. Blakely.* 9 July 1863.

5403. *Chairman.*] I PUT into your hands on the last day upon which the Committee met, a plan of a gun which you had put in. Will you state to what portion of your evidence that plan refers?—It refers to several portions. In the first place, to my answer to question 4626, in which I say, "I may say that I consider that the coil system was at that time a mere makeshift. The object of the coil system is to get welds of wrought-iron round the gun, in that form in which they will be least mischievous; but it must be evident that if we can get rid of the weld altogether, we gain an advantage." Again, at question 4743, I am asked for a drawing, and my answer is, "Yes, I will give it in."

5404. That is the drawing that you referred to at that answer?—That is the drawing.

5405. There are three drawings put in by you, then?—Yes.

5406. Mr. *Laird.*] How long is it since this drawing was made?—That identical drawing which I put in was made in 1860; I merely brought it here, having it in my possession, to show the principle; but it was an old drawing.

5407. Captain *Jervis.*] Is that drawing supposed to represent merely a general idea of the coil system?—That drawing was a drawing of a coil made for me long ago, and I brought it to show the Committee the defects of the coil system. It is a drawing which I have exhibited on certain occasions, in public; for instance, at a lecture which I delivered at Leeds.

5408. It is merely a general drawing, to explain what your idea of the coil system is?—It was a drawing of an actual coil made.

5409. But not with regard to any particular point?—My object was to show the defects of the coil system.

5410. Mr. *Beecroft.*] Had you at that time produced a gun on that principle?—Yes.

5411. Captain *Jervis.*] Where was that?—At Liverpool.

5412. When?—The first gun I made on that principle was in 1859. I mean strictly on the coil principle. In 1855 I had made guns on an analogous principle.

5413. Colonel *Dunne.*] Will you point out on this drawing the advantages and errors of the coil system?—I think any person looking at that drawing must see where the weakness of the coil system is, and that a gun made entirely on the coil system would be very likely to blow its muzzle out, or break at a blow.

5414. When you say "entirely," do you mean the inner part of the gun made on the coil system?—The Armstrong gun, according to the definition of Sir William Armstrong, is made entirely of coils inside and out. I believe practice has shown that the guns do blow their muzzles out, and are liable to break at a blow.

5415. Your object in presenting this drawing is to show that clearly to the Committee?—Yes.

JOHN ANDERSON, Esq., called in again; and further Examined.

J. Anderson, Esq.

5416. *Chairman.*] SINCE the Committee assembled to-day, a paper furnished by you with regard to certain statements contained in a letter from the Elswick Ordnance Company, dated the 16th of June, has been furnished to the Committee. Is there any further explanation that you would wish to give with regard to the statements contained in that paper?—I think not; I have brought some models of guns, sight gauges, and so on, so that the matter may be gone into; it will then be more clear to the members of the Committee; but the paper itself, which was written in a great hurry, goes into most of the points.

5417. This is the paper which you furnished to the War Office, is it not?—Yes; the explanation which I have to offer is this: that where any new thing has to be organized by our system of working, where we have to be ready to repeat the thing again, it is first necessary to make standard gauges before we commence the manufacture. The more this matter is gone into, the better it will come out for the Royal Gun Factory; there

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are many of the things which are really dear, but the reasons can be very distinctly shown, and I am quite prepared to answer any question on this matter.

5418. Captain *Jervis.*] Has your attention been drawn to the comparison between the accounts of the manufacturing departments of the Gun Factory, and the return of the cost of articles given in last year?—No.

5419. Will you look at the return of the manufacturing department, and take the last figure but one in page 22, which you will find is "Hammers, percussion, for 110-pounder Armstrong gun"?—Yes.

5420. The total cost for that is 7,178 *l.*?—Yes.

5421. How many percussion hammers did you make for the 110-pounders?—There were upwards of 2,000 made.

5422. How many 100-pounders were made?—I do not know.

5423. Six hundred and seventy-nine, I think?—Yes.

5424. That would give about 3*l.* odd apiece?—Yes.

5425. Now, if you look at page 206 of the Return of last year, you will find that you there put it down at 1*l.* 1*s.*?—I can well believe it; but I want to explain that long before we came to make those hammers, we had made them in many different ways, expecting that they were to be the kind we wanted. You see what a complete thing it is now (*producing a hammer*). I should like to impress upon the Committee that these gauges, if they are not positively right in every way, are of no use at all. In conducting experiments the money soon goes; it is our best men that carry out this sort of thing; we are paying them 8 *d.* an hour.

5426. Taking this return of last year, you put down percussion hammers at 1 *l.* 1 *s.*?—Yes.

5427. But in this return they come to over 3 *l.* 3 *s.*?—Yes, but it arose in this way: the young man who made out this statement had no idea that it was going to be printed; it is only one list out of volumes of vouchers that we supplied; a gentleman from the Accountant General's Department had gone into the matter, and he was satisfied. The instructions given were to condense it as much as possible, and in giving those headings the young man just caught the first words of many of those things. I cannot explain that offhand; but I will put in a return to the Committee, if it is desired, which will explain it fully.

5428. Will you tell the Committee, generally, which of the two returns is right?—I should suppose both are right; but the one refers to all the expenses incurred in connexion with the thing, and the other to the price at which the bare hammer can be made.

5429. This year's return from the Accountant General is supposed to show the actual cost during the preceding year, is it not?—It has assumed that shape since the paper was printed, but the original intention was only to show in what way the money was spent.

5430. And that is what I want to get at; for there is 7,000 *l.* spent in percussion locks, is there not?—Yes, in connection with that article, and in fitting them; but that expense includes 4,688 *l.* in labour, and in material 556 *l.*, which I have no control over. The per-centage which goes down to that, is another thing which may be discussed, as there are different opinions on that.

5431. Therefore, do you mean to say the Return of last year, at page 206, merely shows the cost of labour?—I do not suppose that; I suppose it gives wages, material, and share of expenses.

5432. Mr. *Baring.*] Did you intend to state that you are not accountable for the material?—Yes, I am accountable, but I have not much control over it; of course there is none wasted.

5433. You are responsible for the economical use of the material, are you not?—Yes, of course, but I cannot control it much. This Return of last year is correct, I do not doubt.

5434. Captain *Jervis.*] Then I suppose the other is incorrect?—No, they are two different things; that embraces all the expenses the department was put to before we could begin to make those percussion hammers, and includes brass frames and rollers, the hammers, tools, gauges, and every kind of incidental cost.

5435. Then that does not represent the actual cost?—No, not in that sense; before you can begin making an article like this, you have to spend an enormous sum of money; next year, I daresay, there will not be these expenses.

5436. But still the cost is a guinea; last year and afterwards it is three guineas?—Very likely, and I have explained the reason.

5437. Colonel *Dunne.*] Why is not that reason stated in the Return?—It should have been stated in the Return.

5438. At page 22, there is 62,950 *l.* charged for sighting and browning Armstrong guns?—There were constant changes made in the sights from time to time. As every fresh sight came to be settled, it was supposed we had obtained the right sight, and we were obliged to make expensive tools and gauges: one of these (*producing an instrument to the Committee*) embraced 37,000 parts, which had to pass through our hands during the year.

5439. *Chairman.*] Upon whose authority were those alterations in the sights made, from time to time?—We had authority for all alterations.

5440. General *Peel.*] That of the Ordnance Select Committee, I suppose?—We had authority for all the alterations; but I cannot say, offhand, whose authority.

5441. Sir *John Hay.*] Had you any authority but that of the War Office?—No.

5442. *Chairman.*] Did you, in every separate case, obtain the authority of the War Office for any alteration in the sights?—We generally obtained authority for all the important alterations.

5443. Could you put in before this Committee some of those authorities, with respect to the changes in the sighting?—I daresay I could, but I am not quite sure at the moment whether I could or not.

5444. But I suppose the War Office could put them in?—There were an enormous number of large guns to be sighted. There is all the difference in the world between a thing being nearly right, and a thing being altogether right; we tried to make these guns right altogether, and the necessary matters and arrangements for doing that cost a great deal of money.

5445. The Committee simply desire to know by what authority those alterations and changes were made: was there any alteration made, in any part of an Armstrong gun, without your having a definite authority from the War Office?—I really

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—I really could not answer that question without looking into it, but I will do so.

5446. General *Peel.*] Were those alterations only experimental alterations?— No; when a gun gets away, one person says, "I like this;" another person says, "I like another thing;" and no part of the gun has been so much criticised and altered, backwards and forwards, as the sight.

5447. Mr. *Laird.*] Were the orders to make those alterations and changes given in writing? —I am not quite sure; many of them were.

5448. You would not make the alterations, I suppose, without the orders being in writing?— The tendency, of course, was to do everything as soon as possible to forward the manufacture; Sir William Armstrong was very anxious to get things forward, and so was the War Office, and I jumped heartily into any change for the better that was proposed. I would not undertake to say that I was always fortified with an order, but I was in most of the instances.

5449. Colonel *Dunne.*] Is it the fact that you had general permission to make certain alterations if you found it necessary to do so?—I do not know that, I had that in writing.

5450. But had you a certain discretion, though you would not make any large alteration without authority?—Yes, that is just it.

5451. Mr. *Beecroft.*] Had you general instructions to do your very best to attain the greatest possible accuracy?—That is exactly the light in which we looked at it.

5452. *Chairman.*] Was that instruction given you in writing?—I am not quite sure about that.

5453. Mr. *Laird.*] Would you make these alterations of your own accord, without the sanction of Sir William Armstrong?—I should not make them of my own accord.

5454. Do I understand you to say that your authority came from the War Office?—It is difficult to clear this all up at once. I have not given great attention to the subject, but I am quite sure that everything would be found right if we got to the bottom of it.

5455. Mr. *Baring.*] I gather from your evidence that you conceive that in the manufacture of your articles, in the experimental stage, a certain amount of discretion is requisite for carrying out alterations without formal authority, and that such a discretion was left in your hands? —Yes.

5456. I understand you to convey that if every minute change in every article were to be stopped on its way until the matter had gone through all its stages, and until formal authority was given from the War Department to make the change, very great delay would have occurred?—No doubt; and particularly at the commencement of the manufacture.

5457. General *Peel.*] And you would consider the alterations as experimental alterations, until you had come to some decided improvement with respect to the gun?—Yes; the fact is, it took this shape: when we first began, say, with the 12-pounder, which was the earliest gun, the sight was made of silver verniers with steel bars, and so on, and of a great many parts; in course of time that came to be simplified, 20 parts came down to five or six parts.

5458. Sir *John Hay.*] That being cheaper?— At all events very much better; then the Navy, and some of the officers at Shoeburyness, began objecting, some to one thing and some to another; we tried to bring it to perfection, and you must see there has been an enormous degree of thinking and working spent upon it.

5459. General *Peel.*] I am sure you will understand that nobody is objecting to these experimental alterations; but the Committee presume that you having received a sealed pattern, there would be no authority to alter that sealed pattern, unless the alteration went through the Ordnance Select Committee?—The Ordnance Select Committee would have given its sanction to an alteration before we sent an article out.

5460. Then, when you had got an alteration through its experimental stages, and brought it to perfection, you would submit it to the Ordnance Select Committee?—Yes; I can quote authority for all that, I am quite sure.

5461. Mr. *Baring.*] The pattern having been sealed, you manufactured according to the pattern? —Quite so.

5462. Captain *Jervis.*] But with respect to this 62,000*l.* for sighting and browning Armstrong guns, that would read as if it applied only to the sighting and browning of the guns made during that year; but does it do so?—It refers to the number of guns that were taken as they came from proof, with all their scratchings and defects, and they were put to rights (put to rights in the interior to within a thousandth part of an inch); and then came the sights, the sighting, and the browning.

5463. The words are simply sighting and browning; would it be sighting and browning, or a number of other things included?—All the other work, besides, connected with the guns after the proof till they were handed into the store.

5464. All that extra work cannot be included, can it, under the head of manufacturing "spare fittings"?—In the column opposite to that, you will find it refers to from 10 to 36 orders.

5465. But you say this item includes putting the inside and outside of the gun in order?—Yes; and also all the tools which are made, including cranes for lifting, and the rest of it.

5466. But how does all that come to be under the head of "spare fittings"?—It would have taken several pages to have given the details.

5467. But should it not have gone to another page, under the head of the actual cost of the gun?—No; for everything that was done to a Gun Factory gun, was done to an Elswick gun just the same.

5468. If you will turn to page 24, you will find that all these expenses with respect to sights are put there over again; is that additional, or is it a portion of the sighting you have just been speaking of?—That on page 24 had nothing to do with Armstrong guns.

5469. What is the cost of browning a gun?— Not very much.

5470. What is the cost of sighting a gun?— We do it very cheaply.

5471. What do you call cheap; what does it cost to sight a 110-pounder?—For the actual sighting, 2*l.*

5472. And for the browning?—2*l.* or 3*l.*; but sighting has nothing to do with making the sights or cutting out the gun.

5473. You have got nothing down here but sighting and browning?—If that had contained everything that was done to the guns, it would have made a bill as long as a stair-carpet.

5474. What was the expense of making the sights

sights and putting them on to an 110-pounder?—I could give you that in detail afterwards.

5475. But, generally, was it 40 *l.* do you suppose?—No, nor 25 *l.*

5476. And it would be much less for a 12-pounder?—Yes; the estimate that was given in 1862-63 was 35 *l.* 10 *s.* for a 110-pounder; for a 40-pounder, 24 *l.* 1 *s.*, and for the other sizes 16 *l.* 10 *s.* Now, taking them all through, including six travelling-frames, and machinery to finish and machinery to polish, and all the plant, it only came to 40 *l.* for every gun.

5477. Did it cost as much as that sighting and browning the Armstrong guns all round?—No; the sighting did not come to half the money.

5478. Therefore the 62,000 *l.* odd does not represent the sighting and browning only?—No; the headings of this statement are badly given, I quite admit.

5479. It does not give the information that was desired?—No.

5480. Sir *Morton Peto.*] The entire expenditure was allocated by an accountant in the best way he could, and you did not look into it to the extent to which you would have done, if you had known that it would have been produced to this Committee?—That is exactly it.

5481. Mr. *Baring.*] I understand from your letter to this Committee, that the accounts of the Royal Gun Factory for the year 1862 will be given in greater detail than they were for the year 1861, and that for the current year 1863 you expect to make the accounts very nearly perfect with respect to the cost of the articles?—Yes; so far as the detail is concerned, I have made an alteration which will keep the balance-sheet right; that is to say, in sending a written order for any change in the work, I am at the same time to send a copy of this order to the Account Branch, so that they will be able to give an explanation of those things when they come upon them a year or two afterwards. At the present time they have only the original order sent to them. In the balance-sheet statement Mr. Rendel would only see the words, "Pulley for crane;" but then that was really for 10 pulleys, and, in addition, I had to put up scaffolding, and so forth.

5482. That, of course, would not be seen on the face of the account?—No; the person who compiles the accounts could not know that. He would only look at the original document, by which he would see that something was to be done to a crane.

5483. The alteration which you have now made with respect to these orders would enable you accurately to work out the cost of each article produced?—Yes; but in repairing cranes, or a steam-engine, or anything of that kind, for another department, it is difficult to give the precise price beforehand.

5484. That would go down to general expenses, but I am referring to the actual production of miscellaneous articles: I presume you would desire to give a list of the cost of each article?—Yes; it will not be satisfactory until that is adopted with every war store, and I should very much like to have determined the right way of distributing the expenses.

5485. Have you made up your own mind on that subject?—Not exactly. There are some discrepancies pointed out by Mr. Rendel; the item referring to the Exhibition ought to have gone down, I think, to General Expenses, but it would take a very clever accountant to say what would be the right way of estimating depreciation, and distributing the general expenses so as to have plant at the proper value on the books after 20 years. I do not see my way through the whole thing clearly yet, and what is wanted is some good authority to say, positively, what is the right thing to be done, and to which everybody would be willing to conform.

5486. Colonel *Dunne.*] Do you recollect being examined before the Organization Committee?—Yes.

5487. Were not all these matters laid down clearly at that time?—Yes; but there is such a long way between speaking of a thing in a general way, and making it exactly right in practice.

5488. You mean to say that the Government have never enforced the recommendations of that Committee?—I think it will take two or three years before it all comes right.

5489. But two or three years have already passed, have they not?—We are gradually getting right, but it is a very formidable thing to do.

5490. But you admit that these accounts, as they stand, would have the effect of misleading any committee?—They do not state enough of the detail, which is now wanted; but they are not intended to mislead.

5491. Can you account for the cost of those models which are before you?—I never did anything that I tried to make cheaper than those models; but they had to be made perfect, at least I tried to make them perfect. I should very much like to take them to pieces before the Committee, and to show you all the plant and tools required to make these intricate moulds.

5492. Mr. *Beecroft.*] Do the prices which are given as the cost of the guns manufactured in the Royal Gun Factory include all the experimental expenses, and the additional cost arising out of any new manufacture?—In every case where there is a large order, in cases where it may appear in this balance-sheet, of experimental things, such as for rifling the shunt-guns, and so on; but wherever we have a large order for guns, the expenditure given embraces everything connected with the making of them.

5493. Including the experimental expenses?—Yes; but there was not much of that at the commencement.

5494. General *Peel.*] You had a gun furnished to you, I suppose?—A drawing.

5495. Where did that drawing come from?—From Sir William Armstrong.

5496. From the Elswick Ordnance Company?—Yes.

5497. Therefore, experiments had been carried out there before the guns came to you?—There were no experiments made; they were made long before the Committee took the matter up.

5498. When were all those experiments made?—The guns were made at Elswick.

5499. Did all the cost of those experiments fall on the Elswick Company?—I do not know.

5500. *Chairman.*] Were they not made before the Elswick Company was formed at all?—I should think so.

5501. With the assistance of Sir William Armstrong, could you from the very first have manufactured at Woolwich the Armstrong guns?—Yes, I should say so.

5502. Now, with regard to the whole number of

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of guns that were manufactured both at Elswick and at Woolwich, do you suppose that, if the 85,000 *l.* which has been paid to the Elswick Company as compensation had been given to you for any additional machinery or buildings, you could yourself have manufactured the whole of the guns that were made both at Elswick and at Woolwich?—I am not quite sure of that, because in the first year and, I might say, in the second year, we were just at our very best. I was working as hard as possible, but after the second year I could have made a greater number of guns; by spending more money we could have done more work.

5503. Suppose you had had at your disposal that 85,000 *l.* for the purpose, would it have enabled you to make all the guns which were made both at Elswick and at Woolwich?—It would, at all events, have gone a great way towards it; but I will say this, and I say it after turning it over in my mind a good deal, that I am quite sure we were all the better for that competition.

5504. In what way were you better for that competition?—We did our best to get the things done in the shortest time, at the least cost, and as well as we possibly could.

5505. Would you not have done your very best if there had not been that competition?—Yes; I will not say that it was for the sake of rivalry, but I certainly think that competition did us a great deal of good.

5506. There were certain articles which you manufactured at Woolwich that were not manufactured by the Elswick Ordnance Company, and there were certain articles manufactured by the Elswick Ordnance Company that were not manufactured at Woolwich?—Yes.

5507. Did you find that you did not get on as well with those articles that were manufactured exclusively at Woolwich as you did with the others?—There was no difference.

5508. You exerted yourself as much in the case where there was no competition as in the case where there was competition?—Yes, we did.

5509. General *Peel.*] Was there free communication between the two places? —Quite.

5510. Was every improvement that was adopted in the manufacture at one place adopted in the manufacture at the other place?—Mostly.

5511. Mr. *Laird.*] Now that the Elswick Company is done away with, do you mean to say that you have relaxed in your exertion in getting the work done cheaply and quickly?—No; I am sorry to say I work too hard at all times.

5512. Do you work harder now than you did in 1859?—I work as hard now as ever I did.

5513. You have stated that you thought competition did good, and yet you say that you did all that you could have done then, and that you do all that you can do now that Elswick is done away with?—Yes; but I am still of opinion that competition is a very good thing.

5514. Then I suppose you are of opinion that it was a bad thing to do away with the Elswick Company?—I only state that competition is a good thing, as a general principle.

5515. The Honourable Chairman asked you, if the 85,000*l.* handed over to the Elswick Company for compensation by the Government had been expended in additions to the buildings and machinery at Woolwich, if that would have enabled you to do all the work that was done both at Elswick and at Woolwich?—Yes; I say it would have gone a great way towards it.

5516. Do you think that by exertions on your part, and the outlay of that money, you would have been enabled to make all the guns?—I dare say we should.

5517. And there would have been a considerable saving to the country, would there not?—I suppose there would have been some saving to the country.

5518. You know the charges that have been made by the Elswick Company, and you know the cost at which you yourself could have made those guns?—Yes; there would have been a saving, no doubt, if we had made them.

5519. A considerable saving?—Yes; but I am unwilling to say anything very strong on that subject, because you see that it is not clearly settled what are the expenses to go down against the gun. So far as labour is concerned, nobody will beat us; it would require great exertion to beat us in the matter of wages or in materials; we do not lose much, unless it is in coals. Even the Honourable Member for Falmouth seems not to have made the subject of general expenses quite clear, and I am not near so able as he is to discuss the question.

5520. I gather from you that you have always done your work in the most economical way possible?—I am quite sure of that.

5521. And you have put in a statement of your prices?—Yes.

5522. And you know the prices that have been charged by the Elswick Ordnance Company?—Yes.

5523. And there is a vast difference between the two?—Yes, there is a difference.

5524. May not the balance of that statement of prices be considered as profit?—After adding all the other expenses it may.

5525. Then all the difference between the charges made at Elswick, and the amount at which you could have done the work at Woolwich, is (after adding the proper charges) the difference of cost to the country between employing Elswick and making those guns at Woolwich?—Yes.

5526. Mr. *Baring.*] The whole matter turns upon a question of the added expenses?—Yes; if we could agree upon that, we could get on.

5527. But that is not now agreed upon, and therefore the real cost has not been ascertained? —No; we went into the subject last year, and did not seem to get any nearer to what the real cost ought to be.

5528. *Chairman.*] The question which we have to settle is the actual cost to the Government of the article manufactured; now you, of course, had land and old buildings and old machinery, which you had to adapt to the manufacture of the Armstrong guns; those things could not have been used for any other purpose but the manufacture of the Armstrong guns; therefore there ought to be nothing charged against you for them; is not that so?—So far as the Government is concerned, that is quite correct; but a private individual has to take every expense into consideration, and charge accordingly.

5529. But we have not to consider whether the Elswick Ordnance Company charged a fair price, that being quite a separate question from the question of the actual cost to the Government of the guns at Woolwich, and what would have been the actual saving to the country if the whole of the guns had been manufactured

at

at Woolwich?—No doubt they are quite distinct questions.

5530. Colonel *Dunne.*] But why should not the same elements enter into the price of the manufacture by the Government and the price of the manufacture in a private establishment?—That is what we all desire to agree about, but cannot do so.

5531. Were not Mr. Anderson, of the Treasury, and Mr. Arbuthnot employed as a Committee for making up those accounts?—Yes. I read their evidence; but it did not make any impression on what has been done in the War Department.

5532. But I understood that the Government was to adopt the system in each department which was recommended by those gentlemen, who are eminent as administrators; has that been done?—They came round to the Gun Factory, and they went into the accounts, and were particularly well pleased with them.

5533. Did they lay down certain data on which the prices were to be calculated?—Not that I know of.

5534. Mr. *Baring.*] That Committee which went to Woolwich had more to do with the question whether there should be an accountant sent to Woolwich, or whether the departmental system should be continued; they did not enter into the way in which the balance-sheet should be made out?—No.

5535. Captain *Jervis.*] You have been asked whether, if the 85,000 *l.* which was paid to Elswick had been expended at Woolwich, you could have done at Woolwich the whole of the work: now, there were times when you had a good deal of hard work to do at Woolwich, and there were times when you had also very little to do at Woolwich?—That last condition has never fallen to my own share.

5536. I do not mean you, but the Arsenal, that has at times been very slack?—Yes.

5537. If the slackness continued for a long time the guns would cost a very high price?—No doubt.

5538. Do you, therefore, think it would have been really economical to extend those factories at a great expense?—There is no doubt that the guns this year will be very dear; the labour will not be much more, nor the material; but the expenses will be very great.

5539. Therefore the actual cost to the country is not the actual price of the guns when Woolwich is full of work, but the price taken over a series of years, including years when Woolwich may not be full of work?—Yes.

5540. The cost this year may next year be doubled?—Yes, in expenses, but not in labour and material.

5541. Mr. *Laird.*] Then, on your principle of spreading the fixed charges over a larger amount of work, the cost of making the guns would have been less at Woolwich, supposing you had done the whole of the work there?—Yes.

5542. *Chairman.*] Let me also ask you what has become of the 85,000 *l.* paid to the Elswick Ordnance Company; are the Government likely ever to derive any advantages from that money?—I should say not.

5543. Mr. *Baring.*] Are you aware that, although that amount of 85,000 *l.* was paid to the Elswick Company, the Government are to receive a certain quantity of machinery and stores from them, which are to cost 20,000 *l.*, so that the real amount of the compensation would be reduced to 65,000 *l.*?—I believe so.

5544. Captain *Jervis.*] Suppose you had spent that additional 85,000 *l.* in plant, and that that plant was not kept in full work, would it not be an actual loss to you for every year when you were not working?—Yes.

5545. Therefore, it would not have been real economy to spend that 85,000 *l.* at Woolwich, would it?—If it had paid itself at first, it would have done its work; but money there doing nothing would have been a losing affair.

5546. Mr. *Laird.*] Would it have been better for the Government to have become possessed of even 65,000 *l.* worth of plant for 65,000 *l.*, or to throw the plant into the river?—It would have been better to have it, I should say.

5547. Captain *Jervis.*] Even if you did not employ the plant?—Yes, I think so; if it was my own, I should prefer to have it than to see it in the river.

5548. Mr. *Beecroft.*] Sir William Armstrong has informed the Committee that for the outer tubes of his guns he prefers coiled wrought-iron, and Captain Blakely says he prefers cast-steel; which do you prefer?—With my present experience, for the outside, I would trust more to wrought-iron than to steel; but I think that the time is not far distant when we shall have steel tough enough for that purpose. I would not, however, venture upon it at present myself.

5549. Have you made any experiments in cast steel for the outside of guns?—No, not for the outside, but I have tried it for many other things.

5550. Can you explain to the Committee the difference between Captain Blakely's plan and that of Sir William Armstrong?—I understand Sir William Armstrong's plan very well; Captain Blakely's plan, I know, is very like it in some respects. I have seen the specification of his patent, and I think it very like Sir William Armstrong's.

5551. In what respects is it like Sir William Armstrong's as regards the inner tube?—I do not know that there is much difference.

5552. You think there is very little difference between the two guns?—I do not think there is much difference between the two guns in the specification, so far as I recollect.

5553. Mr. *Laird.*] Is there any difference in the mode of carrying the thing out?—I know very little of Captain Blakely's plan, but the two guns are very much like each other in general feature.

5554. Sir *John Hay.*] Do you suppose that whichever of the two gentlemen may have been the later inventor infringed the patent of the other?—I never thought of the matter in that light; I dare say there may be some differences, which would make out the two patents to be quite distinct.

5555. Mr. *Laird.*] Do you think that after Sir William Armstrong's guns have been made and spread all over the world, there could be any great secret in his patent?—There is no secret.

5556. Then it is no use concealing the specification, is it?—I did not know that it was concealed.

5557. From your knowledge of the method in which the guns are manufactured, the manufacture having been thrown open to all the world, do you consider that any engineer, having seen the

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the Armstrong gun made, could make one like it?—I think so.

5558. You think that keeping the patent secret is of no value whatever?—I think not; but there may be reasons for it.

5559. Captain *Jervis.*] Are you aware that the Secretary of State considers that it is of importance to keep the patent secret, and will not permit this Committee to have it?—No, I did not know that.

5560. Mr. *Laird.*] Will you refer to Question 1984: "I understand you to say, in answer to a previous question, that after our large experience in the manufacture of guns, you do not think we have got the best possible gun for the service; what did you mean to convey to the Committee by that remark? What I mean is, that all the good is in no system, nor all the bad; that if we could only manage to pull together for a short time, we should soon get a good gun; but while we go on each one working for himself on his own system, it is difficult to get at things that will give ultimate satisfaction." Will you explain what is meant by that answer?—When I said that, I dare say I meant it more as a general proposition, but after all that answer expresses my opinion more than anything else I have said; if we could only drop standing up for this thing and the other thing, my belief is that we should soon get a good gun for the Government.

5561. Have the plans of the Armstrong guns often been changed from time to time?—Yes.

5562. You stated that all that was done by a general order from the War Office: I suppose it would be in communication with Sir William Armstrong?—Sir William Armstrong took the first steps in these matters, and obtained the proper authority.

5563. And those alterations were made from time to time at the expense of the Government?—Yes, so far as the Royal Gun Factory was concerned.

5564. Then, if Sir William Armstrong has made a perfect gun, it has been made so at the expense of the country?—Yes, so far as concerns the Gun Factory.

5565. But so far as the gun has advanced towards perfection, that has been done at the expense of the Government?—So far as the Gun Factory is concerned, that is the case.

5566. Colonel *Dunne.*] Have any improvements been suggested at Elswick?—Many.

5567. Have any improvements in that gun made at Elswick been suggested to the Royal Gun Factory and adopted by them?—I do not doubt it.

5568. Therefore, the improvements were not made entirely at the expense of the country?—I only said that anything done in the Arsenal was of course at the expense of the Government.

5569. Sir *John Hay.*] Do you think the improvements have been worth what they cost?—I do not think you could have obtained for less that which you have obtained.

The Right Honourable the MARQUIS OF HARTINGTON, a Member of the Committee, further Examined.

Marquis of *Hartington.*

5570. *Chairman.*]—YOUR Lordship has this morning handed in a letter from Mr. Anderson?—Yes; and I wish to make a short explanation with respect to that letter. Lord De Grey's attention was called to Mr. Rendel's letter, which contains statements with respect to the accuracy of the balance-sheet which has been laid before Parliament, and which appeared to him to require explanation. Mr. Anderson was, therefore, called upon for an explanation, which explanation is contained in the letter now before the Committee. The Committee expressed a wish to have Mr. Anderson's remarks on Mr. Rendel's letter placed before the Committee in a written form; and Lord De Grey has, therefore, consented that that letter should be put in. I wish, however, to state that this is simply the personal explanation of Mr. Anderson, and is to be taken for what it is worth as such; and that it must not be assumed that it is an explanation put forward by the Department, or even that it is considered by the Department to be in all respects satisfactory.

5571. Colonel *Dunne.*]—Do the Department intend to put in any explanation themselves?—I think not.

5572. Do you think it would be desirable to obtain some explanation from the Department?—The Committee have not asked for one.

HENRY W. S. WHIFFIN, Esq.; called in again, and further Examined.

H. W. S. Whiffin, Esq.

5573. *Chairman.*] YOU are probably aware that there has been some controversy with regard to Paper 44, showing the comparative cost of guns and projectiles manufactured at Woolwich and those manufactured at Elswick, and that some of the statements contained in it have been questioned?—I have seen a letter from Mr. Rendel on the part of the Elswick Ordnance Company, and, with the permission of the Secretary of State for War, I made a few observations thereon, and the paper is now before the Committee.

5574. I believe that you have been selected to go out to India, to deal with the military accounts there?—An application has been made by the Indian Government for my services for a short period, in connexion with Public Works in India.

5575. Will you state to the Committee what steps you took, in order to ascertain the cost of projectiles and the various descriptions of Armstrong guns and projectiles?—I visited the Gun Factory 12 months since, and went through the accounts generally, and made a report thereon, which report was submitted to this Committee during the last Session of Parliament. Since that period Mr. Hurst has been appointed, on the part of the Accountant General's Department, to make a detailed examination of the accounts of the manufacturing departments.

5576. Have you any doubt that the return which you put in accurately represents the cost to the Government of the different articles referred to in it?—The balance-sheet shows very satisfactorily, to my mind, the expenditure on labour and material and the general charges; and

and as there was a question, which arose during last Session, with respect to the correct mode of distributing the general charges on the balance-sheet, I showed the results in two ways; that is to say, the result from distributing the general charges on direct labour, and also on direct labour and materials.

5577. Was there much variation between the two?—The difference is about 9,000 *l.* or 10,000*l.* on guns; that is to say, if you distribute the general charges on labour and materials, the guns manufactured during 1861–62 will have to take between 9,000*l.* and 10,000*l.*, and miscellaneous works at the Factory will be relieved by that sum.

5578. Are you aware whether Mr. Anderson of the Treasury, who is the highest authority on this subject, has considered the question of the different accounts at Woolwich, and whether he has approved of them?—I do not think that his attention has been ever drawn to the detail of the Army manufacturing accounts: he gave a general approval of the books in existence two or three years since; but I do not think his attention was ever drawn to the principle of the accounts as now rendered.

5579. Could you have done more than you did to ascertain the real costs of the articles produced at Woolwich if you had been, for instance, going to invest money in any private firm, and had their accounts submitted to you?—I should have been quite satisfied with the reports made to me by Mr. Hurst, who made a detailed examination, having first satisfied myself that the principle was, in my opinion, correct.

5580. I do not think that, in your comparative calculation, you took into account the amount of compensation given to the Elswick Ordnance Company?—No, it was not included.

5581. Did you take into account the extra charge mentioned by Captain Gordon with regard to packing-cases?—No; there was no charge of that description made. I have given, in the Returns, information as to where I obtained the prices; and the prices shown by that statement do not include the cost of packing-cases and other small charges, alluded to by the Principal Superintendent of Stores.

5582. Therefore, the question before the Committee being, not with regard to whether the prices charged by the Elswick Ordnance Company were fair prices or not, but the actual cost to the Government of the guns manufactured at Woolwich, you have no doubt that your statement was accurate, and that it represents very nearly the actual cost of those guns to the country?—The Balance-sheets for 1861-62 show accurately, I believe, the expenditure that has taken place at the different departments, during the year, on guns and other articles manufactured in the Government Department; and I think the result is perfectly correct.

5583. Do you know whether there is any sum of money set down on account of the machinery and buildings that were erected for other purposes at Woolwich, which have been used for the purpose of manufacturing Armstrong guns and projectiles?—The Capital Account of the Royal Gun Factory was taken from a statement put in by the Assistant Superintendent during last Session. I believe that the first item he includes in that statement is for the year 1854, and he then adds, year by year, the amount spent upon new machinery and new buildings that have been added, and deducts depreciation; so that perhaps, with regard to the 4,000 *l.* taken in that statement, it may be considered to represent the assumed value of the buildings in existence before the Gun Factory was extended.

5584. But in order to get at the actual cost to the Government of the articles produced at Woolwich, as compared with those produced at Elswick, nothing should be taken into account except the sum they were forced to spend in order to make the buildings and machinery available for the purpose of the new manufacture; is not that so?—That may be so, but the amount taken over was very small in 1854; it was only 4,000 *l.*

5585. Mr. *Laird.*] Generally, do you confirm the correctness of those accounts in Paper 44, showing that a saving of 242,000*l.* would have been effected if the work had been done at Woolwich instead of at Elswick?—I can only state that the result of that expenditure, compiled from the statements that I alluded to, shows that difference between the charges made at Woolwich and those paid to the Elswick Ordnance Company; but whether the whole amount of that saving would have been effected I cannot say.

5586. But according to your best information, this is a correct account of the cost of what was made at Woolwich?—Yes.

5587. And the other is a correct account, from documents, of what has been charged by the Elswick Ordnance Company?—It is. But it must be also stated that the amounts shown as the Woolwich rates are the results of the general charges distributed on labour only; but if they were distributed on labour and material, it would make a small difference.

5588. Would it be more than 10,000*l.*?—About 10,000*l.*

5589. That would reduce this amount of 242,000*l.* to 232,000*l.*?—Yes.

5590. That does not include 65,000*l.* compensation, does it?—No.

5591. Then the difference would have been nearly 300,000*l.*?—65,000*l.* added to that sum would produce the amount you state.

5592. Then what is shown in this statement as a saving to the Government would have been nearly 300,000*l.*?—Those amounts added together make 300,000*l.*; but whether that saving would have been effected, I am not in a position to state.

5593. If your statement is correct that you have put down the cost of those articles at Woolwich, I can see no other conclusion?—That statement merely shows the difference of price between what was charged by the Elswick Company, and what we assume would have been charged if the guns had all been manufactured at Woolwich. But there are a good many other things to be taken into consideration, which I have not gone into.

5594. What are they?—Among other things, the advantage of keeping up two establishments.

5595. *Chairman.*] This saving which you have referred to was made not on the whole amount, but only on the articles that you were able to compare. The whole amount spent was 2½ millions, and your comparison is only between 593,000*l.* and 351,000*l.*, which is considerably less than one-half: is not that so?—Yes.

5596. Therefore, the whole saving would have been considerably more than double the amount stated just now?—I will not say that. The result was about 40 per cent. in favour of the

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articles mentioned; but whether that would be the case on other articles, I cannot say.

5597. Mr. *Laird.*] Forty per cent on 593,000 *l.*?—Yes.

5598. Sir *John Hay.*] Have you taken into account everything, rent, taxes, and interest on buildings?—There is depreciation and interest on capital charged in that statement.

5599. And everything that would be charged in a private establishment?—I will not say that it is everything that would be charged in a private establishment, because there are a great many little items which the Government are not called upon to pay; but the result shown is the amount of labour and material and the indirect charges; but those indirect charges consist only of those charges actually paid by the Government.

5600. Therefore it is not exactly a fair comparison with regard to a private establishment, is it?—It is a fair comparison, with the omission of those small items. It has also been urged that we should include a certain amount for the use of cranes, wharves, roads, and so on, which are not charged in the account.

5601. Nor is the groundrent charged?—Nor groundrent, because none is paid.

5602. It is merely the actual disbursement?—It is merely the actual disbursement, plus the depreciation of plant, and interest on capital.

5603. Without considering the value of the fixed capital?—A certain charge for fixed capital is included; that is to say, interest on capital.

5604. But what represents the capital?—It is an assumed amount, which represents the supposed value of the buildings and machinery when the establishment was taken over by the Assistant Superintendent of the Royal Gun Factory, to which has been added, year by year, the cost of new buildings and new machinery.

5605. Without reference to the groundrent?—Without reference to the groundrent.

5606. Or to rates and taxes?—Or to rates and taxes.

5607. Or to any charges that would be incidental to a private etablishment in the same position?—The only items excepted are the rates and taxes, wharves, sewers, ground rent, and insurance.

5608. That would form a very considerable item, would it not?—Not with regard to our establishment at Woolwich, because no payments are made on account of some of the items; and in regard to the roads, wharves, and sewers, they are necessary for the Military Store establishment, and existed long before the Gun Factory was developed to its present extent.

5609. *Chairman.*] But, would the expense for roads have been increased if the whole of the articles made at Elswick had been made at Woolwich?—No doubt there would have been some additional charge, because the roads would have required additional repairs.

5610. That would have been an infinitesimal charge, I suppose?—So small that we did not consider it worth while to introduce those fictitious items into the comparison.

5611. Captain *Jervis.*] The assumed value of the buildings of the Gun Factory is quite a recent one, is it not?—When I said the assumed value, I merely meant that you commenced in 1854 with 4,000 *l.*, which is supposed to represent the value of the buildings then existing; but I believe the Capital Account, as shown by Mr. Anderson's statement, is as correct as it could have been made at the time, and represents the amount of money expended in buildings and material, year by year, since 1854.

5612. Has your attention been drawn to the discrepancy between the return furnished in July 1862 and the return sent in this year?—The Committee must bear in mind that the balance-sheets were not made out for this Committee; they were asked for by Mr. Newdegate; the whole of the balance-sheets were ready for presentation, and we were under the impression that they would answer the two objects of Mr. Newdegate and this Committee. If this return had been prepared solely for this Committee, I have no doubt that it would have been rendered in greater detail in regard to the miscllaneous articles manufactured.

5613. Take the 62,000 *l.* for browning and sighting Armstrong guns, as shown by the Returns for 1862: that comes to about 40 *l.* per gun, but according to this return it would not be 20 *l.* per gun?—We have no means of ascertaining whether the prices are high or low; we can only state from examination what money has been expended on that description of order.

5614. In the Return for 1862, they give the actual cost of each article?—The amount shown in that return for sighting and browning has been actually expended on that order; but perhaps, if the orders themselves were referred to, a more satisfactory result could be arrived at.

5615. But the two returns seem actually to be antagonistic, do they not?—I have no doubt that the Assistant Superintendent of the Royal Gun Factory could explain the apparent discrepancy; I am only responsible for the Balance-sheet for 1861–62. They have been audited by an independent auditor, and the result is that a sum, as shown by the balance-sheets, has been expended on those orders.

5616. Colonel *Dunne.*] You said that the plant that was handed over for the purpose of manufacturing Armstrong guns was calculated at 4,000 *l.*?—There was a return laid before the Committee last Session, which showed in the fullest detail the manner in which that Capital Account was made up.

5617. How was that estimate made?—That estimate was made up and signed by the Assistant Superintendent of the Royal Gun Factory, and on that we based our Capital Account for 1861–62.

5618. That was merely an assumption?—It was the nearest approach to a correct account that could be made at that time.

5619. You took the Capital Account as handed to you?—Yes; I took it as rendered to the Committee?

5620. And you do not consider yourself responsible for that account?—Not at all.

5621. If that is wrong, the whole calculation founded on it is wrong?—We have guarded ourselves against that; because in the Balance-sheet of 1861–62 we merely show by a memorandum the results which would be arrived at by including a charge for depreciation on capital, by a per-centage on the amount of production; we do not add it to the price of the gun.

5622. But you would not call it a commercial account?—It is very difficult to make Government accounts on commercial principles.

5623. Therefore it is as difficult to compare commercial prices with Government prices, is it not?—I do not think there is very much difficulty in making a comparison of the prices charged

charged by a private establishment and those of the Government; that is to say, making a comparison for Government purposes.

5624. Is it not an object to know whether the Government could manufacture themselves more cheaply than they could purchase from a contractor?—Certainly.

5625. Those accounts would not furnish you exactly with that information, would they?—Approximately they would, and as nearly as you can hope to arrive at it.

5626. But if the accounts are not commercially kept in some way, how can you compare the prices?—We know that for a certain sum we are producing a certain number of articles, and that enables us to arrive at a satisfactory rate.

5627. But if that is not put together in that commercial form, you cannot know the relative prices, can you?—Those extra charges, depreciation and interest, are shown by the per-centage on the amount produced, and you can add a certain further per-centage to cover certain other items not actually paid by the Government.

5628. We had in the account of last year a certain price given for certain articles, and we have two or three times that price in the next year?—The prices given last year by the Assistant Superintendent of the Royal Gun Factory were founded on estimate only; the balance-sheet for 1861–62 shows the gross expenditure for each class of work, including the cost of experiments, &c.

5629. There is no principle in the Government accounts then, is there?—No general principle in regard to the distribution of the general charges has yet been adopted.

5630. Do you recollect that Mr. Anderson, Mr. Arbuthnot, and I think yourself, were examined before the Organization Committee on this very point?—Mr. Anderson and Mr. Arbuthnot were examined, but I was not; it was before my present appointment.

5631. Mr. *Beecroft.*] In your statement did you make any charge, for instance, on the value of the land on which the works are erected?—No; because there is no rent paid for the land, and that statement is made up from the rate which has been given in by the Assistant Superintendent of the Royal Gun Factory. I adopted them, thinking it advisable that the Committee should have those figures in preference to any new ones.

5632. You accepted those figures as your data?—Yes; I accepted them as my data, and gave the Committee a reference to the Returns and the page of the Report where those figures would be found.

5633. Mr. *Baring.*] With regard to Appendix 44, "Showing the cost of certain guns and projectiles obtained from the Elswick Ordnance Company, compared with the rates of those produced at the Royal Arsenal, Woolwich;" and the results which appear to follow from that statement, namely, a difference between the Woolwich and Elswick rates of 242,000 *l.* odd, did you go into the question of the dates of the different orders, and whether the orders were of the same amount, with a view to determine whether this saving to the country would have taken place, if the orders had been given to Woolwich instead of to Elswick at the time when the orders were given?—The prices quoted as paid to Elswick are those which were paid for the gross number of the articles they have made, and the prices shown for the Royal Arsenal are those which are stated in the Returns alluded to; but there was no adjustment of the amounts in consequence of the smaller number of the articles made at Elswick.

5634. Those points were not considered in preparing the Return, No. 44?—No.

5635. Do you think it is fair to compare prices which have been paid in the experimental stage of a manufacture and for small orders, with prices paid after the manufacture has been through its experimental stage and for large orders?—Certainly not, for, doubtless, an article can be manufactured for less when the orders are larger.

5636. Does not that observation apply in the main to the whole of the comparison instituted in this table?—Some items might be affected by that circumstance.

5637. Take, for instance, the 110-pounders: there were 209 110-pounders made at Elswick, whereas at Woolwich the order was for about 500?—The amount put down for the Woolwich price extended over two years, and after the gun had been made for some little time at Elswick.

5638. And the order to Woolwich was much larger than the order to Elswick?—The order to Woolwich was for 495 guns, and the order to Elswick was, I think, for 259.

5639. But, besides that, there were 81 manufactured in 1860 at Woolwich, were there not?—The number manufactured during the year 1860–61 was 81 110-pounders.

5640. According to the balance-sheet for 1861 there were 81?—There were 575 manufactured during 1860–61 and 1861–62.

5641. So that, really, you would be comparing the price of 209 guns made at Elswick with the price of 575 guns made at Woolwich?—Certainly.

5642. Now, with regard to those 100-pounder guns for which you put down the price as 700 *l.*, were you aware that there were certain materials which went in diminution of that price?—I was not aware of that; I have been unable to trace any rebate by the Elswick Company on account of that circumstance, and I find that the amount actually paid was 700 *l.*

5643. Have you inquired whether any material was returned by the Elswick Ordnance Company?—I have; and I have obtained no information upon that point.

5644. Now, with respect to the other guns; taking, for instance, the 12-pounder, which is one of the large items, are you aware that when those 69 12-pounders were ordered from Elswick, 170 were ordered from Woolwich?—I was not aware of that.

5645. Assuming, which I believe to be the case, that those guns were the first guns manufactured, and, in almost the experimental stage, would not that be an element in the comparison between the price charged at Elswick and the price which is worked out from the very large number which were made at Woolwich?—Yes; but the amount included in that return for the smaller descriptions of those guns is so inconsiderable that I do not think it would make much difference in the aggregate.

5646. Then, to return to the 110-pounder; have you taken into consideration the mode in which they are constructed, supposing the barrels to be made at Woolwich with forgings and at Elswick with coils?—I have no means of arriving at information with respect to many of the details.

5647. Then there are many circumstances essentially

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essentially affecting the comparison which it would be out of your power to decide upon?—Yes; and, therefore, I gave the Committee references to the returns from whence I obtained my information.

5648. Now, with regard to the dates of the orders, and the manufacture being in its experimental stage; does not that apply in the main to the whole of the ammunition; is it not the fact that the high prices of the ammunition were for a year previously to the time at which the ammunition was made in the Royal Laboratory, and in many cases for small orders?—With respect to prices that are included in the return, the Arsenal prices are for 1861–62, when they commenced manufacturing in the Royal Laboratory; and the prices for Elswick are taken from the bills that were actually paid the Company.

5649. That includes the prices of the whole of the projectiles manufactured at Elswick from the commencement of the manufacture?—Yes, on those natures that are compared with each other.

5650. Therefore, in that case more especially to compare the prices when the articles were first manufactured with the prices after the manufacture has been very considerably extended, would be unfair, would it not?—I merely made the comparison from the results that I had before me, that is to say, from the documents to which I referred the Committee in the notes.

5651. You took the prices paid in the one case, and the cost of the articles in the other?—Exactly.

5652. It was not for you to point out other matters that might affect the soundness of the conclusion that might be drawn from those figures?—Certainly not; I merely showed the broad results.

5653. Now, with regard to the actual rates, you took them from page 136 of the Appendix to the Report of this Committee of last Session?—Yes.

5654. In that page you find a return which gives a very different cost; take the 100-pounder gun, for instance, is not the cost of the gun very different there?—Yes, in consequence of the difference in the distribution of the general charges, the question being whether they should be distributed on labour only, or on labour and material combined, as in the Accountant General's branch, we have always agreed that the nearest approach to correctness is to distribute the general charges on direct labour only, we took that plan in preference to the other, giving the Committee references to the accounts from which the cost was taken.

5655. It makes very little difference in the main if you distribute those general expenses over the whole produce of the factory, whether you take it one way or the other, does it?—With respect to the production of the year 1861–62, it makes a difference of about 10,000*l.* either for or against the gun; but with respect to the projectiles made at the Royal Laboratory, I think it was rather in our favour than otherwise.

5656. But with respect to the rates, taking the balance-sheet of the year, do you consider that to be satisfactory?—I will not say that it is quite satisfactory; it is our first trial. It is much more complete than it has ever been yet, and I trust that subsequent years will show a more satisfactory result.

5657. With regard to the balance of stores and semi-manufactured articles in hand at the beginning of the year, and the amount of the stores and semi-manufactured articles at the end of the year, do you take that from the statement of the superintendent, or has that been audited by an independent officer?—That has been taken from the return given by the superintendent, and, to a certain extent, verified by the departmental auditor, but we have not yet had an opportunity of going into every minute account. I could not have done so with the present strength of the department.

5658. Has it been verified with respect to the quantity of stores in stock?—With respect to quantities it has been verified.

5659. Has it at all been checked with respect to the value?—The prices are from the returns of the previous year, so far as regards the stores in stock on 1st April; the value of the stores on 31st March is obtained from the average rates paid during the year.

5660. Suppose those stores and stock contained a large mass of materials, the price of which may have fallen since they were bought?—That would form an element in the result for the year.

5661. But if you have a large amount of stores in hand, as in the case of the Royal Laboratory, and in the carriage department more especially, it may make the whole of the difference with respect to the cost, whether the sum put down in the balance sheet is the nominal value or the actual value of the stores in hand?—It would make a considerable difference, and, in fact, forms an element in the annual results.

5662. Can you make out a real balance sheet without estimating your stock in hand?—Certainly not.

5663. And that is in a state of progress, but the result you desire is not yet arrived at?—The stock in hand is taken by the heads of the several departments only, and is merely at present verified by comparison with the quantities shown in the store ledgers.

5664. Take buildings and machinery, that is a clear case of expenditure in the year, is it not?—That merely shows the amount of new buildings and new machinery acquired in the year, but repairs to existing buildings and machinery have been charged to the production account.

5665. That is real expenditure?—Yes.

5666. You can either divide that on the cost of the articles in the year, or you can charge depreciation; you must bring it out in the cost somewhere?—Yes.

5667. Which do you think is the right way?—I think the course I have adopted is the most satisfactory; namely, by adding the new buildings and machinery to the capital account year by year, and showing the results by a percentage, and not by actually including it in the general balance sheet of the year.

5668. Coming to the production account, it is calculated two ways; first, by dividing the general expenses in proportion to the direct labour; and secondly, by dividing them on the labour and material?—Yes.

5669. Therefore it is necessary to be clear that you have got the whole of the general expenses?—Yes.

5670. Did you look through the return of the miscellaneous services in the Gun Factory for the year 1861?—Yes.

5671. Is it your opinion that there are no entries in the production account which should properly be put down to general expenses?—Perhaps one or two items should have so treated, but they are rather the exceptions, more particularly with regard to the charge of 2,000*l.* for

for certain models for the Exhibition; it might be critically correct to charge that sum to the general expenses of the year, but even that is open to argument.

5672. Suppose the Elswick Ordnance Company had sent models to the Exhibition, would they not have had to charge them to general expenses?—With a private firm it is different, because they would get a collateral advantage in the nature of advertisements.

5673. How could the Elswick Ordnance Company obtain that advantage when they cannot take orders?—I do not know whether they would derive any advantage, but the superintendent of the Gun Factory might not have wished to exhibit for his own satisfaction, and he might have considered it rather a hardship that his department should be charged with that expense.

5674. Then the list of miscellaneous productions is very incomplete for this year, is it not, inasmuch as it does not bring out the list of articles produced, showing their cost?—It does not, and that defect is one which I hope will be remedied in subsequent accounts.

5675. Till that is done it is impossible to say how this very large sum of 203,560*l.* is actually composed?—Quite so: but, if necessary, I have no doubt that a return could be prepared showing in more liberal detail the whole of those items.

5676. It appears that by shortening the heads under which the expenditure has been given many items are included under heads which do not properly belong to them, they being of a totally different character?—The return shows generally the expense under each class of service, but it is for consideration whether the whole of the return should not be extended.

5677. I am alluding to it merely as a part of this annual balance-sheet. Does it not appear to you that unless you work out for the Gun Factory, as you have worked out in the Carriage Department and in the Laboratory, the number of articles produced and the price, this return is of very little value?—Yes; our great desire has been to keep down the expense of auditing those accounts.

5678. In respect to the audit at the War Office, you would require no more auditors, would you?—If we were made responsible for the whole of these details, we must have an increased number of gentlemen employed in the audit.

5679. It would be for the superintendent of the department to work out how much he had charged himself with respect to the different articles, and you would hardly go yourself into the question of the audit of each of the different articles?—That is a question; hitherto we have not done so.

5680. After depreciation has been considered, and the division of the general expenses, there would be interest on capital to be charged if you wish to show the whole of the cost of the articles?—If you wish to include elements of that kind, it must be shown in the balance-sheet, but I would prefer its being shown as per-centage, and not as a defined charge, because it is a fictitious charge.

5681. You think that showing that in a note is the best way?—I think so.

5682. Now with respect to depreciation and general charges and interest, taking this establishment of the Royal Gun Factory as producing a mass of miscellaneous articles of all kinds, and a certain number of guns, how would you distribute those charges? Have you considered that question?—The most correct way, speaking generally, I think, is to distribute the general charges on the amount of direct labour employed on each article. There may be some few services conducted at the Royal Gun Factory which ought not to be subject to any proportion of the general expenses; but generally I think the most correct way is to charge them on the direct labour.

5683. How would that affect the cost, for instance, of the larger repairs, browning and sighting guns, and work of that sort; if you put the general charges on all this work, which after all requires a very small portion of the machinery which is used in the factory, would you not be throwing the main weight of all these incidental charges upon work which really ought not to be charged with it?—No doubt it would have that effect, but after all you must have some general principle to guide you; and, taking all things into consideration, I do not think you can approach nearer to correctness than by distributing the incidental charges on the direct labour.

5684. For the purposes of the accounts, as far as the Government are concerned, it is a matter of very small importance, because if the Government knew the way in which the expenses are distributed, they could make allowance for any apparent anomalies?—Yes.

5685. But when you come to compare the cost of articles produced in the Government factory with the cost of articles produced in a private factory, the comparison would be very much deranged, would it not?—Certainly.

5686. Therefore do you think we can arrive, from these figures, at any satisfactory conclusion by way of a comparison between the prices charged at Woolwich and the prices charged by the Elswick Company?—I think that as the balance sheet shows the three main elements, viz. labour, material, and general charges, it may be generally taken as correct. If you wish to take into account the points you have raised, you must add a certain per-centage to cover those charges, which would be very small.

5687. When you say it would be very small, have you calculated the sum which would come out in 1861 for guns, if you adopted what is suggested by the Elswick Company should be adopted, namely, to put down for miscellaneous services 15 per cent. to cover the general expenses, and depreciation, and interest, and put the remainder of the general expenses, depreciation, and interest, on the guns?—I have not made a calculation of that kind, because I do not admit the general correctness of their principles.

5688. Take the case of those articles in the miscellaneous list; if, for example, you sent a labourer from one place to another, do you think that you ought to charge his wages with a portion of the sum spent in the year for repairing machinery, and with a portion of the depreciation on machinery and buildings, and with a portion of the interest on capital?—No, I think not; and perhaps you might throw out of the account some few of those exceptional items which come to a very small amount.

5689. Take that large item for browning and sighting guns; the browning of guns requires no machinery, does it; it might be done in a shed?—I do not know.

5690. At all events it is clear that expensive machinery is not required for that purpose; do you think that that item, which is a very large one,

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one, should be charged with a portion of the cost of keeping up the expensive machinery which is necessary for manufacturing Armstrong guns; do you think that depreciation upon that machinery, with interest on the capital, should be charged upon browning and sighting guns, when, properly speaking, no capital at all would be required?—Perhaps not, and perhaps it would be more satisfactory if you were to fix upon certain productions which should bear the charges of depreciation, interest, and so on.

5691. Those questions being so difficult, and the sums given in this balance sheet as the cost of miscellaneous articles being so large, being nearly half the whole produce of the factory, do you not think that those questions materially affect the subject of comparison of the cost of the guns?—Those are points which must be taken into consideration.

5692. Those are points which must be taken into consideration, and some division must be made of those miscellaneous items?—It would be very desirable no doubt to arrive at a definite principle, and of course that would affect the results of the calculations shown in the account.

5693. The whole of those great difficulties which attach to the cost of the gun, as shown in this balance sheet for 1861, apply very strongly to those different estimates which Mr. Anderson put in last year, do they not; all those estimates would have been produced on that same basis, I suppose?—Yes.

5694. And therefore the whole of the difficulties which apply to the cost of the guns as shown in this balance sheet would apply to the rate on which you calculate the comparison between the Woolwich and the Elswick prices?—Yes.

5695. General *Peel.*] When did the difference between the prices charged at Elswick and the cost of the manufacture at Woolwich first appear in the accounts?—The first question that arose on the subject was before this Committee last Session, I think.

5696. It had never struck the War Department until last Session that there had been a great difference between the prices charged at Woolwich and the prices charged at Elswick?—The War Office was scarcely in a position to arrive at that until the accounts for the Gun Factory had been made up in their present form.

5697. Was any objection made to the Elswick prices with respect to future orders, or were they still reported upon as fair and reasonable?—I am not aware.

5698. But there was power, was there not, at any time to close the accounts with the Elswick Ordnance Company?—Yes.

5699. Did not the proportion of that 300,000 *l.*, which might have been saved if Elswick had been put an end to, include the whole of the guarantee to the Elswick Company?—The 300,000 *l.* is the amount shown in Statement 44, plus 65,000 *l.* paid to the Elswick Ordnance Company on account of compensation.

5700. *Chairman.*] Will you kindly state what was the cost of the whole of the 12-pounders supplied for the service, and also of the 40-pounders, and of the larger guns?—The total amount expended on the 12-pounders, including the sums paid to Elswick, and also the expenses at Woolwich, was 56,193 *l.*: for the 40-pounder, it was 221,567 *l.*; for the 70-pounder, 33,496 *l.*; for the 110-pounder, 463,383 *l.*; for the 300-pounders, 14,600 *l.*; for the 600-pounders, 4,000 *l.*

5701. That is on one 600-pounder, is it not?—I believe it is; the total being 793,239 *l.*

5702. It has been suggested that as the orders for 110-pounders were much larger in one year than those given to the Elswick Company, it being cheaper to manufacture a large order than a small one, that is one reason for the difference in price between Elswick and Woolwich?—It has been so urged.

5703. But suppose the Woolwich Arsenal had had the whole of the 110-pounders to make, would not that very consideration lead you to believe that they would have been able to manufacture them even more cheaply than they did?—They might probably have manufactured them cheaper, because the general charges would have to be distributed over a large amount of production.

5704. Coming back to the actual cost to the Government for each article produced at Woolwich, after all the questions you have been asked, are you still convinced upon the whole, and speaking generally, that the return which you put in is an accurate return, and conveys a true impression?—It conveys an impression that that difference would have resulted if the articles had been manufactured at Woolwich instead of at Elswick; that is to say, the prices as shown by those returns, and the prices paid to the Elswick Company, produce that result.

5705. Mr. *Baring.*] Do you believe that the inference which the Chairman suggests to you, could fairly be drawn?—My own impression is, that that return shows a fair statement. Of course different people draw different conclusions from the same data, and the statement in question is, as far as I am concerned, only a compiled account.

5706. *Chairman.*] But still you are so convinced of its accuracy, that you would be prepared to act upon it yourself if necessary?—I am satisfied of its accuracy.

5707. Sir *Morton Peto.*] It is substantially accurate?—It is, in my opinion, substantially accurate.

Lieutenant Colonel Edward Morier Boxer, called in; and further Examined.

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5708. *Chairman.*] Sir William Armstrong stated in answer to Question 4994, asking why the projectiles were not manufactured at Woolwich in the Royal Laboratory at first, "I think the reason was that Colonel Boxer objected to any interference on my part;" will you kindly inform the Committee whether you objected to carry out any instructions which you received from the Secretary of State for manufacturing ammunition and projectiles for Armstrong guns?—No; I never objected to carry out any instructions received from the Secretary of State in relation to the preparation of ammunition for Sir William Armstrong's gun in my department. The letter which I handed in last Session will show that the Secretary of State was perfectly satisfied with me in respect to this matter. It is in the Appendix of the last year's Report, at page 223; it was in answer to a letter I had written, complaining of my not having received an order to manufacture Sir William Armstrong's projectiles after being told by Lord Herbert that they were

were to be made in the Laboratory Department. The last paragraph of the answer, signed by Sir Benjamin Hawes, is as follows: "Far from entertaining any feeling of a want of confidence in you, Mr. Herbert, while reserving to himself entire discretion as to the manner in which the duties of the various manufacturing departments are to be distributed, feels fully satisfied that whatever portion of these duties may be confided to you, they will be as zealously and conscientiously performed as he has found has hitherto been the case."

5709. Can you tell the Committee why the projectiles and fuses for Sir William Armstrong's guns were not made in the Royal Laboratory from the first?—The case was a very peculiar one. When the Armstrong system was first introduced into the service, Sir William Armstrong had not had sufficient experience to enable him to determine the best construction of fuze or projectile. Now there were very urgent demands for rifled guns at that time, and it was considered desirable, rather than to stop the manufacture until the best construction was decided upon, to allow Sir William Armstrong to make improvements on his own responsibility as the manufacture was being proceeded with. I know from various conversations which occurred at the War Office, that it was considered a very important thing to fix the responsibility of the success of the Armstrong *matériel* entirely upon Sir William Armstrong, so that he should not be enabled to say, in the event of any failure, that it was owing to imperfect manufacture, or because of things not being carried out in accordance with his wishes. But in order to fix this responsibility upon Sir William Armstrong, it was necessary that he should be allowed to carry out whatever arrangement he thought desirable: so that although the Secretary of State was satisfied that I would do what was right, still, Sir William Armstrong having expressed a wish that the manufacture should be under his immediate superintendence both at Elswick and at Woolwich, it was decided that the shells and fuzes should not be made in the Royal Laboratory in the first instance.

5710. Had Sir William Armstrong any ground for supposing that you would not cordially co-operate with him in the manufacture of the ammunition?—Not in the least. I had shown every desire to carry out his wishes and to improve the *matériel* for his gun.

5711. Sir William Armstrong, in part of his answer to Question 3230, stated, "I can assure the Committee that I have had ten times the difficulty and labour in maturing the fuzes and projectiles than I have found it necessary to expend on the guns." Will you inform the Committee whether you found it more difficult to make a fuze for Sir William Armstrong's gun than for any other gun?—No; on the contrary, I think it is an easier thing to make efficient fuzes for rifled than for smooth-bored guns.

5712. Then what was the difficulty that was suggested by Sir William Armstrong?—He had had no experience whatever in the construction of fuzes, and therefore he laboured under great disadvantages.

5713. Is it not natural to suppose that proper fuzes would have been arrived at sooner if they had been made, from the first, in the Royal Laboratory?—If Sir William Armstrong had taken advantage of the experience of the Royal Laboratory he would have saved himself much unnecessary labour; and I have no doubt we should have arrived at a better result than that attained by Sir William Armstrong, after all the labour he has bestowed in his attempts to make efficient fuzes for his shells.

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5714. I think you stated in your former examination that with the plant and machinery which you had at your disposal, you could have made the whole of the ammunition fuzes and shells that were made both at Elswick and Woolwich?—Yes.

5715. Do you conceive, as has been suggested, that there would have been any much greater expense in the manufacture of the early fuzes and shells than of the later ones?—Not the slightest; we had to commence the manufacture in the same way as the Elswick Ordnance Company had to commence. With respect to the experiments connected with the manufacture we had quite as many experiments to make, when we began, as the Elswick Ordnance Company; no doubt we had had much greater experience in manufacturing projectiles than the Elswick Ordnance Company, and, for that reason, we were able to manufacture from the commencement cheaper than they were.

5716. I believe that you have heard the questions that were put to Mr. Whiffin. Are you perfectly convinced, taking all those matters into account, with regard to depreciation and everything else, that you could have saved to the country, if those articles had been all manufacsured at Woolwich, the sum stated by Mr. Whiffin?—I have no doubt in the world about it.

5717. Mr. *Laird.*] With respect to charging per-centage on labour; if you were to charge the indirect expenses on labour and material combined, what difference would it make in the cost of the Armstrong guns?—If we had charged the indirect expenses on the labour and material instead of on labour alone, the Armstrong projectiles in 1861-62 would have been made for about 1,200 *l.* less than the sum stated in the balance-sheet.

5718. Can you give any evidence to show that the indirect expenses have not been unduly put on Armstrong projectiles?—Yes; I am enabled to give conclusive evidence upon that point. Before we commenced to manufacture Armstrong projectiles (that was in 1859-60, I think), we sent in a similar balance-sheet to that which has been handed in to the Committee, showing, in detail, the cost of all the various articles manufactured in the department. In the next year, besides the articles that were made in 1859-60, there was also, in addition, the Armstrong projectiles. Now, if you compare the prices of small-arm cartridges, fuzes, and other articles of this description contained in the balance-sheet of 1859-60, with the prices in the Return which has been presented to Parliament this year, you will find that the price this year is rather less than it was in 1859-60; consequently, we could not this year have unduly charged the Armstrong projectiles with the indirect expenses; because, if we had done so, it would have increased the price of the other articles I have mentioned.

5719. You have stated that you could have made all the projectiles which you made at Elswick at Woolwich?—Yes.

5720. Do you mean without any additional machinery?—I think there would have been about 1,000 *l.* worth of additional foundry apparatus required, because the demands were very large

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large for some natures of projectiles. I think that 1,000 *l.* would have been sufficient to have enabled us to manufacture the whole of what has been supplied from Elswick and from Woolwich.

5721. If you had known, could you have reduced the cost?—Slightly, perhaps, but not very much.

5722. Do you think that the competition between the two establishments has tended to reduce the cost?—I think so with regard to Elswick, but it has not reduced the cost of the projectiles made in the Woolwich Arsenal. I have not the slightest doubt that my offer to make the projectiles at a comparatively small cost was brought to the notice of the Elswick Company, and induced the Elswick Company to come down in their prices. I do not think there is any doubt about that: in the last year they came down more than 50 per cent. I think the first prices for the 110-pounders and the 40-pounders were 1*l.* 3*s.* 9*d.* and 13*s.* respectively; and this year they offered to supply them at 15*s.* 5*d.* and 8*s.* respectively.

5723. You were enabled to do them cheaper, because it was a business in which you had had much experience, and which was a new business to them?—That was one reason, no doubt.

5724. Colonel *Dunne.*] Do you calculate in the general charges rent of buildings, and so on?—Rent, certainly not, because we do not pay it.

5725. And the value of buildings?—Interest and depreciation is not charged in the Return just presented to Parliament; but there is a note referring to it, stating that, if charged, it would increase the cost by 3·379 per cent.

5726. That would make a difference, would it not?—Very little.

5727. And then as to rent?—We do not pay rent. The return was not made out for the purpose of comparing the prices at Woolwich with the contract prices, but to show the amount which would be required to be voted by Parliament for the supply of certain articles.

5728. Are you aware of a German fuze made nearly on the principle of Sir William Armstrong's?—Yes; the arrangements are a little different, because Sir William Armstrong is obliged to light his fuze by means of a detonator, the other is lit by a flame from the charge.

5729. Do you know that that was offered to this Government some years ago?—I think that was not the same.

5730. Was Mr. Beaumont the discoverer?—He was the first to arrange the composition in the horizontal way.

5731. Mr. *Beecroft.*] In your calculation of the cost, do you charge experimental expenses as well as new machinery?—All the expenses which are required to enable us to manufacture an article, I charge to that article; if we are required to make a certain number of experimental shells all the expenses incurred are charged to those experimental shells. In the manufacture of the Armstrong shells we had to make a great many experiments before we were able to manufacture them economically, and of the required quality. Then there was another expense attending the manufacture of the first shells: Sir William Armstrong objected to the arrangement which I had adopted in casting the shells, and I was directed by the Secretary of State to carry out Sir William Armstrong's views with respect to the mode of casting, and the consequence was that the whole of the plant which had been prepared for carrying out my method of casting became useless, and I had to make apparatus for the carrying out of Sir William Armstrong's wishes; all that was included in the cost of the shells issued.

5732. Did you include new machinery?—All the repairs of machinery in the year were charged to the production.

5733. And the alterations of machinery as well?—Yes, trifling alterations of machinery; but very large alterations, which would increase its original value, would be charged to the plant.

5734. Mr. *Baring.*] In the balance-sheet for the Laboratory for 1861, I see two headings, one for miscellaneous services, the amount of that being 21,246 *l.*, and one for machinery, the amount against that being 20,249 *l.* Do you think it would be advisable to put in explanatory statements of those figures?—Certainly. I am very anxious to have it done in detail.

5735. Now, unless we have a certain amount of detail, the accounts do not give us all the information which is necessary?—No; but the Accountant General has the whole of it,

5736. Your account has always been kept in the greatest detail?—Yes; of course we improve from year to year.

5737. With respect to the early stages of the manufacture of the Armstrong projectiles, your evidence is, that Lord Herbert having fully considered the matter, decided that they should be made under the superintendence of Sir William Armstrong?—Yes; it was considered that if that were not so, the responsibility would not rest with Sir William Armstrong.

5738. Sir *Morton Peto.*] Was that Sir William Armstrong's own request?—Yes.

5739. General *Peel.*] Was not that one of the conditions to which Sir William Armstrong gave up the patent of the gun to the Government?—I do not think there would have been any difficulty in doing it under his superintendence in my department.

5740. Mr. *Baring.*] With respect to one or two cases which took place in 1861, did you consult Sir William Armstrong as to the manner in which you were manufacturing his projectiles?—Yes, at the request of the Secretary of State.

5741. But if he had the responsibility, he would naturally desire he should be consulted, would he not?—I always asked for information upon any point that I had doubts about.

5742. Without in the least discussing the question who was right, the fact is that Sir William Armstrong considered the way in which you were making a part of the projectiles, in 1861, was not satisfactory, and he applied to the War Office upon the subject, and Lord Herbert issued directions that they should be made in the way he thought right?—I thought it rather an extraordinary proceeding for Sir William Armstrong to report to the War Office, instead of coming to me.

5743. But that was what took place?—Yes, but I can read a portion of a letter which will show that Lord Herbert was quite satisfied upon the subject. This letter is dated, War Office 29th June 1861: "Lord Herbert feels confident that Sir William Armstrong and you will cordially co-operate together in this respect, in order that your joint experience and ability may secure the largest amount of benefit to the public service." There was never any doubt entertained about my doing what was right. The question referred to the mode of casting shells. I adopted the mode

mode which had been followed out in the department for a great many years, and which had proved successful. Sir William Armstrong, however, objected to the plan.

5744. Naturally enough, you having had very great experience in the manufacture of projectiles, considered that you knew which was the best method; and naturally Sir William Armstrong, having also had experience, though perhaps not so much as you, thought his the best mode?—Yes; only he did not come to me. He went to the Secretary of State about it.

5745. Sir *Morton Peto.*] I understand you to say that when some alterations were thought desirable by Sir William Armstrong with respect to the method of casting, his wishes were fully met by you?—I will read the letter which I wrote to him, dated the 25th of June 1861:—"Royal Arsenal.—Dear Sir,—I find from a letter just received from the War Office that you are not satisfied with the method adopted in the Laboratory for casting shells of your construction. Although I have myself perfect confidence in the plan now objected to, which has been followed for some years in this department with great success, I have, in obedience to instructions received from the Secretary of State, directed immediate steps to be taken to run the moulds with the base downwards. Will you be good enough to inform me at your earliest convenience whether you consider it necessary to cast all sizes and natures (common and segment) of shells in this way, and of any other points which, in your opinion, require special attention in connexion with the operations of manufacture of the ammunition for your gun. I shall be happy to show you, at any time, all that we are doing in this branch of work, and it would be a satisfaction to me if you would pay us an occasional visit."

5746. Practically, would Sir William Armstrong have been in the same position at Woolwich, with respect to the manufacture of those projectiles, as if the buildings had been entirely his own?—So far as I am concerned, he would.

5747. Then supposing Sir William Armstrong had produced a projectile in exact correspondence with the pattern sent to you, there would have been no difficulty?—None.

5748. General *Peel.*] At 1309 of last year's Evidence you will find this question addressed to yourself, with this answer: "Did Sir William Armstrong ever object to the manufacture of projectiles in the Arsenal at Woolwich under his own superintendence?—I do not know; I should have objected very strongly to that when the shell was actually introduced into the service."—Yes; that was a different thing. I have been referring to the time when the shell was in an experimental stage, and when Sir William Armstrong was allowed to make any alteration which he might think necessary in order to improve it; but when the shell was once introduced into the service, and the sealed pattern and specifications were supplied, the responsibility would rest entirely with me. Still if the Secretary of State had given me orders to carry out a certain work in accordance with Sir William Armstrong's wishes, I should have done it, though I should have stated at the same time that I could not take the responsibility of what was being done.

5749. Colonel *Dunne.*] Do you know whether there are any reports on those fuzes from the Ordnance Select Committee yet?—I am not aware.

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March 1854 -	Mr. Whitworth proposed to undertake a series of experiments, with a view to securing by the help of machinery, the greatest possible exactitude in the manufacture of rifle barrels.
January 1855 -	A Committee was formed, consisting of— Mr. Whitworth. Captain Jervis, R.A. Lieutenant Lutyens, 20th Regiment. Mr. Westley Richards. Captain (now Colonel) Dixon succeeded Captain Jervis, and Captain (now Lieutenant Colonel) Younghusband replaced Lieutenant Lutyens.
January 1856 -	The subject of guns rifled on Mr. Whitworth's system was before the Ordnance Select Committee from January 1856 until the formation of the "Special Committee on Rifled Cannon" in September 1858. In 1856, the Ordnance Select Committee consisted of— President: Major General W. Cator, C.B., Director General of Artillery. Vice-President: Captain J. C. Caffin, C.B., Naval Director General of Artillery. Members: Colonel R. Hardinge, K.H., R.A., afterwards succeeded by Colonel W. B. Gardner, R.A. Colonel P. Cole, R.E., afterwards succeeded by Lieutenant Colonel Walpole, R.E. Colonel A. Tulloh, R.A. Lieutenant Colonel W. H. Askwith, R.A. Lieutenant Colonel F. Eardley Wilmot, R.A. Lieutenant Colonel W. M. Dixon, R.A. Captain P. J. Bainbrigge, R.E. Captain C. W. Younghusband, R.A., F.R.S. Captain E. M. Boxer, R.A. Captain C. F. Young, R.A. Professor Sylvester, F.R.S. F. A. Abel, Esq. J. Anderson, Esq. Associate Members: Professor Wheatstone, F.R.S. C. H. Gregory, Esq. Secretary: Colonel Pickering, R.A. Assistant Secretary: Captain F. A. Campbell, R.A.

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July 1856 - A Sub-Committee of the Ordnance Select Committee was appointed, consisting of—

Lieutenant Colonel F. Eardley Wilmot, R.A.
Captain Younghusband, R.A.
Captain Boxer, R.A.
Mr. Burton.

With whom the following officers were associated:—

Lieutenant Colonel Lefroy, R.A.
Captain Warlow, R.A.
Mr. Penn, C.E., F.R.S.
Mr. Anderson.

Their instructions were to "enter fully into the narrative of Mr. Whitworth's proceedings, to ascertain the expenses charged or chargeable to the public for them, and to detail the conclusions deducible from them."

11 June 1857 - A new Committee was appointed, consisting of—

Sir W. Codrington, President (succeeded by Colonel Hutchinson in June 1858).
Colonel Hay.
Colonel Gordon.
Lieutenant Colonel Hudson.
Lieutenant Colonel Dixon, R.A.
Captain Boxer, R.A.
Mr. Whitworth.

The Commander in Chief, and Secretary of State for War being *ex officio* members.

[Dissolved, March 1859.

May 1858 - A special Committee was appointed to enquire into Mr. Whitworth's expenditure on account of experiments, consisting of—

Colonel Hutchinson (President of the Small Arms Committee).
Captain Warlow.
Mr. Anderson.

Sept. 1858 - The "Special Committee on Rifled Cannon" consisted of—

President:

Colonel W. W. Mitchell, R.A.

Members:

Captain Sir W. Wiseman, Bart., R.N.
Colonel W. J. Smythe, R.A.
Major T. M. Wemyss, Royal Marine Artillery.
Captain R. J. Hay, R.A.

Secretary:

Captain A. Noble, R.A.

This Committee was dissolved in January 1859.

June 1859 - The whole subject of Mr. Whitworth's improvements in small arms was handed over to the Ordnance Select Committee, which had just been re-constituted, and now consisted of—

Colonel St. George, R.A., President.
Captain Sir W. Wiseman, Bart., R.N., Vice-President.
Lieutenant Colonel Robinson, R.E.
Lieutenant Colonel Greathed, 8th Foot.
Lieutenant Colonel Smythe, R.A.
Lieutenant Colonel Lefroy, R.A., Secretary.
Lieutenant Colonel F. Campbell, R.A., Acting Secretary.

March 1860 - The Ordnance Select Committee were instructed to report upon Mr. Whitworth's large guns, in comparison with Sir W. Armstrong's.

March

App. No. 1.

March 1860 - A special Committee was appointed in March 1860, to consider the best gauge, &c. for small arms. It was ordered that it should be considered as a Sub-Committee of the Ordnance Select Committee, and consisted of—

President:
Colonel Steele.

Members:
Colonel Horsford, Rifle Brigade.
Colonel C. Kennedy.
Lieutenant Colonel Hudson.
Captain Hayes, R.N.

This Committee was, however, dissolved in June 1860, without having carried out any experiments.

June 1860 - September 1861 - The subject of Whitworth and reduced Enfield Small Arms was again referred to the Ordnance Select Committee, and finally in September 1861 the question as to the best principle of rifling for Small Arms (which included Mr. Whitworth) was referred to the Ordnance Select Committee, consisting of (at the time the experiments were carried out)—

Brigadier General St. George, C.B., R.A., President.
Captain Sir W. Wiseman, Bart., R.N., Vice-President.

Members:
Brevet Colonel Hogge, C.B., R.A.
Brevet Colonel Campbell, R.A.
Lieutenant Colonel B. G. Baynes, Unattached.
Lieutenant Colonel Gallwey, R.E.

Brevet Colonel Lefroy, R.A., Secretary.
Captain Heyman, R.A., Assistant Secretary and Secretary to Small Arms' Sub-Committee.

With whom the following Officers were associated:

Brevet Major Conolly, Coldstream Guards.
Captain Herrick, 12th Regiment.

July 1860 - Colonel St. George, R.A., Colonel Bingham, R.A., and Commander Herbert, R.N., were appointed to witness some experiments with Whitworth's breech-loading guns at Southport, with a view to guiding the Secretary of State in deciding upon the purchase of some of Mr. Whitworth's guns for further experiments.

December 1862 - A Special Committee on Armstrong and Whitworth guns was appointed consisting of—

Major General Rumley, from 12th Foot, President.
Colonel Ormsby, R.A.
Colonel Taylor, R.A.
Captain Preedy, C.B., R.N.
Colonel Simmons, C.B., R.E.
Commander Singer, R.N.
Major Young.
W. Pole, Esq., F.R.S.
John Penn, Esq., F.R.S.
Captain Dyer, R.A., Secretary.

Alexander T. Tulloh, Major General,
Director of Ordnance.

Appendix, No. 2.

App. No. 2.

COPY of a CORRESPONDENCE on the subject of 10-inch SHELLS.

Newcastle-upon-Tyne,
Sir, 17 November 1862.

REFERRING to a conversation which I had with the Secretary of State, and also with Lord de Grey, on the subject of the manufacture of Mr. Whitworth's 7-inch gun in the department under my control, I have now the honour to forward herewith a copy of the correspondence on this subject with tracings annexed. I beg leave to request that these may be submitted to the Ordnance Select Committee, with instructions to report for the information of the War Office whether the assertions recently put forward by Mr. Whitworth in the "Times" newspaper relative to the construction of this gun are borne out by the facts of the case.

As I am precluded from publicly contesting Mr. Whitworth's claims in this matter, I feel it is but justice to myself and Mr. Anderson that an official investigation should be made for the information and guidance of the War Department.

I have, &c.
(signed) *W. G. Armstrong.*

The Under Secretary of State,
War Office.

(Immediate.)

War Office, 13 December 1861.

THE Assistant Superintendent is authorised to put in hand a 7-inch gun to be made in accordance with a drawing which will be furnished to him by Mr. Whitworth, with whom he will place himself in communication on the subject.

The Assistant Superintendent will also prepare five brass 9-pounder blocks, which will be bored and rifled by Mr. Whitworth.

The Assistant Superintendent will be good enough to report the estimate cost of executing the above orders, and to state when the guns will be ready.

(signed) *Alex. T. Tulloh,*
Director of Ordnance.

The Assistant Superintendent of
the Royal Gun Factory.

Royal Gun Factories, Woolwich,
24 December 1861.

Mr. ANDERSON presents his compliments to the Whitworth Ordnance Company, and with reference to his promise to Mr. Hulse, begs to forward a tracing, No. W—82, showing an amended build of muzzle-loading guns. Mr. Anderson also begs to return herewith the four tracings which were left by Mr. Hulse.

Sackville Street Manchester,
Sir, 26 December 1861.

WE are in receipt of your favour of the 24th instant, and beg to inform you that Mr. Whitworth has just returned from Derbyshire, and has seen the tracing No. W—82, showing the construction proposed for the 7-inch gun to be made at Woolwich, and rifled on Mr. Whitworth's principle.

Considering that the mode of construction which Mr. Whitworth would have preferred, and which we have explained to you, cannot, with the facilities now existing at Woolwich, be conveniently carried out, we will avail ourselves of your offer to undertake the responsibility, and to leave the details of construction entirely to yourself.

We may, however, ask you to consider the propriety of omitting the outside hoop shown on tracing W—82, and welding the next series of hoops together, so as to avoid the joints; this would reduce the weight of iron to about 7 tons.

We venture to express a hope that the gun may be proceeded with, with all possible dispatch.

We are glad to hear from Mr. Hulse, that we are likely soon to receive the brass gun-blocks, and beg to ask you to send the sights with them.

(signed) *The Whitworth Ordnance Company.*

Royal Gun Factories Woolwich,
Gentlemen, 31 December 1861.

WITH reference to your letter dated the 26th instant, I beg to enclose a tracing No. W—87, showing the 7-inch muzzle-loading gun slightly altered in the exterior diamter at the breech. With respect, however, to the removal of the outside coil, I am of opinion that this coil is indispensable to the strength of a gun constructed on the plan proposed, and with regard to the welding of the series of hoops under the exterior coil, these hoops are of a much larger diameter than we have yet done, and I am unwilling to run any risk with this gun.

If this tracing meet with your approval, I shall feel obliged by your returning it with Mr. Whitworth's signature, to serve as an authority for proceeding with this construction of gun, the manufacture of which will be carried out with all possible dispatch.

I am &c.
(signed) *J. Anderson,*
Asst. Supt.

Sackville Street Manchester,
Sir, 3 January 1862.

We beg to acknowledge your favour of the 31st ultimo, enclosing tracing (W—87), showing the 7-inch muzzle-loading gun, as you propose to make it. We return the tracing, signed by Mr. Whitworth, as an authority to proceed with its manufacture.

We are sorry to trouble you again about the brass guns, but should be glad if you could send us one or two of them immediately.

We are, &c.
(signed) *Joseph Whitworth & Co.*

J. Anderson, Esq.
Royal Gun Factories, Woolwich.

Royal Gun Factories Woolwich,
6 January 1862.

Mr. Anderson presents his compliments to the Whitworth Ordnance Company, and begs to acknowledge the receipt of their letter of the 3d instant, enclosing a tracing W—87 of 7-inch muzzle loading gun signed by Mr. Whitworth.

Royal Gun Factories,
Gentlemen, 26 March 1862.

I shall feel obliged by your informing me whether the tracing last received from you, showing the section at muzzle of your 7-inch gun, represents the gun in its proper position; that is to say, does the red line I have caused to be drawn, represent the horizontal axis of gun through the trunnions or otherwise? I have also to request that you will state whether it is particular as to the finish of the hexagonal rifling at the inner end of bore.

The enclosed sketch shows the dimensions to which it is thought the rifling can be easily accomplished in this department, and if it meets your approval, it shall be done; if not, however, I shall be happy to meet your wishes.

Your returning the tracing will oblige.

I am, &c.
(signed) *J. Anderson,*
Assistant Superintendent.

Chorlton-street, Portland-street,
Sir, Manchester, 27 March 1862.

We beg to acknowledge the receipt of your letter of the 26th instant.

The red line on the tracing enclosed, represents the horizontal axis of the gun through the trunnions.

The hexagonal rifling will do to be finished at the breech, as shown in the hand sketch enclosed, and to the dimensions given on the sketch.

We return the tracing as requested,

And remain, &c.
(signed) *Joseph Whitworth & Co.*
John Anderson, Esq.
Royal Gun Factories, Woolwich.

Royal Gun Factories,
Gentlemen, 27 March 1862.

I beg to enclose for your consideration two tracings (W—185 & 186), showing a proposed arrangement of sighting the 7-inch muzzle loading guns now being prepared for you in this department If it meets your approval, please return it signed. I shall, however, be happy to sight the guns in any other manner which you may desire.

I also enclose a tracing (W—187), showing the vent-hole in the gun, at the same angle as those in the 68-pounder service guns, and have to request that you will inform me whether you wish this hole drilled in the gun before proof, and copper bouched after proof, or that the gun should be proved without a vent-hole at all.

(signed) *J. Anderson.*

Chorlton-street, Portland-street,
Sir, Manchester, 1 April 1862.

We are exceedingly sorry that, through pressure of business, your letter of the 27th ultimo was not answered by return.

We herewith return the tracings you sent us, showing the sighting which we have signed as requested.

The vent-hole we will leave entirely to you. If you think it better not to vent before proof, please carry it out; or if you prefer to vent before proof, and to copper bouch the hole after, you will oblige us by doing so. In our own guns we have generally proved before venting.

Would you kindly inform us how soon you think the gun will be finished?

We are, &c.
(signed) *Joseph Whitworth & Co.*
J. Anderson, Esq.

Appendix, No. 3.

App. No. 3. CORRESPONDENCE laid before the SELECT COMMITTEE on ORDNANCE relative to 10-inch SHELLS.

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CORRESPONDENCE.

THE Superintendent, Royal Carriage Department, forwarding a Report received from Lieut.-Col. *Clerk*, R.A., on the subject of the Shells for 10-inch Guns.

Royal Carriage Office,
Sir, 16 August 1860.

I LOSE no time in forwarding, for the information of the Secretary of State for War, the enclosed Report from Lieut.-Col. Clerk, R.A., second officer in the Royal Carriage Department, and recommend that this most important subject be submitted for the immediate consideration of the Ordnance Select Committee; and beg to remark that the 10-inch gun, which weighs only 86 cwt., has a shell which appears to me to be, with a charge of 12 lbs. of powder, entirely out of proportion to the strength of the gun, the common and diaphragm shells filled weighing respectively 98 and 107 lbs.

I have, &c.
(signed) *Alexander T. Tulloch*, Col. R.A.
Supt. R. C. D.

The Under Secretary of State
for War, &c. &c.

Lieut.-Col. *Clerk*, R.A., to the Superintendent, Royal Carriage Department, reporting on the weight of some Shells for 10-inch Gun issued for trial.

Royal Carriage Office,
Sir, 15 August 1860.

IN consequence of several instances having occurred lately at Malta, Plymouth, &c. of 10-inch guns recoiling violently and displacing their pivots, I considered it desirable to make a trial of a 10-inch gun on one of the new dwarf traversing platforms, with the stops of the platform advanced two feet, in order to see if this would have the effect (by keeping the centre of gravity of the gun and carriage further to the front) of preventing the platform jumping up when the gun recoiled to the full extent.

For this purpose the usual six rounds allowed for departmental experiments were demanded of, and issued by, the principal military storekeeper, Royal Arsenal. On weighing the shells, which were rivetted to wood bottoms, it was found that they weighed, empty, 90 lbs., the wood bottoms weighing 1 lb. 9 ozs.; and, consequently, when filled with sand, to represent the bursting charge, they weighed 95 lbs.

The charge of powder was the service one of 12 lbs., and the gun was fired point blank, with grummet wads.

For the first round, the surface of the platform was dry, the gun recoiled up to the stops, and the front of the platform lifted about 12 inches.

For the second and third round, the platform was wetted so as to represent what might often happen in bad weather; the gun recoiled most violently up to the stops, displacing the coin, lifting the front of the platform about two feet, and driving back the stops about one-eighth of an inch.

The platform having flanged trucks working on raised racers, on each occasion fell back into its proper position on the racers, but had it been pivoted and with flat soled trucks, the pivots would certainly have been displaced or broken, and the platform would have come off the racers. Thus, the advantage of the new pattern trucks and racers

was

was evident; but, at the same time, the recoil was far too violent, and no carriage or platform would stand it for continued firing.

In all tables and documents giving the weight of the shell for the 10-inch gun, it is laid down as 82 lbs., when empty, and the hollow shot as 84 lbs., nor can I find from any document, that there are two distinct shells for the 10-inch gun, one for land service, and the other for sea service.

The shell for the 10-inch howitzer and mortar weighs, "empty," 86 lbs., but no where can I find any such weight as 90 lbs. for an empty shell, or 88 lbs. 7 oz. without wood bottom.

When the 10-inch gun was introduced into the land service, in the year 1852, it was found that, even with the hollow shot of 84 lbs, the recoil was very violent; consequently the rear friction plates were dispensed with in the carriage for this gun, but it was never contemplated that it would throw such a heavy projectile as 95 lbs. In a table which Lieut.-Colonel Boxer, R. A., forwarded to this Department last April, mention is made of a diaphragm shell for the 10-inch gun, weighing 107 lbs. 9 oz.; now if these heavy shells are to be used with the 12 lbs. charge for land service, it will be absolutely necessary, even if the gun will stand it, that some alteration be made in the traversing platform for this gun.

I, therefore, have the honour to suggest that, as this is a subject of the utmost importance, it be at once referred to the Ordnance Select Committee, for them to consider, and to determine why, if a shell of 84 lbs., including wood bottoms, is used in the naval service, we should have one weighing 90 lbs. in the land service. If the shells and charge of powder are to remain as at present, it will become necessary for us to make some alteration in the platform, to compensate for the violent action of the gun.

The remaining three rounds I propose firing with India-rubber buffers attached to the stops of the platform, to see if they will have any effect in checking the recoil.

I beg further to add, that it would be very desirable to ascertain the weight of the shells used at Malta, Plymouth, and other places where the 10-inch guns have displaced their pivots.

I have, &c.
(signed) *H. Clerk*,
Lieut.-Colonel, R. A.

Colonel Tulloch, R. A.,
&c. &c. &c.
Superintendent,
Royal Carriage Department.

Copy of Report of the Ordnance Select Committee on the Weight of Shells for 10-inch Guns.

(Committee Minute, Nos. 2340, 2381, and 2477. Report, No. 1208, 26/10/60.)

The Committee beg leave to report, that the projectiles originally intended for use with the 19-inch guns of 84 and 86 cwt., were common shells, weighing 82 lbs. when empty; the hollow shot was the same shell filled with sand, to make it weigh 86 lbs., this being the weight of the common shell with the then established quantity of bursting powder. Projectiles of this weight were used up to the time of the transfer of the examination from the Inspector of Artillery's Department to Royal Laboratory Department.

The Committee are unable to trace the introduction of a separate pattern 10-inch shell for land service.

The following Table shows the Average Weight of 10-Inch Projectiles. Average taken from the Actual Weight of 20 or 30 Projectiles, at the Stations named.

Table.

STATIONS.	TEN-INCH PROJECTILES.								
	Hollow Shot.			Naval Shells.			Land Service Shells.		
	Minimum.	Maximum.	Mean.	Minimum.	Maximum.	Mean.	Minimum.	Maximum.	Mean.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Woolwich - - -	86·44	90·44	88·75	77·36	82·19	78·63.	85·44	88·76	86·75
Shoeburyness - -	78·25	88·50	84·28	- -	- -	- -	86·28	90·19	88·13
Portsmouth - - -	78·75	87·75	82·28	75·50	82·75	79·20	85·13	89·62	87·30
Devonport - - -	76·50	89·00	84·07	76·75	81·50	79·16	88·50	89·00	87·15
Average - - -	79·98	88·92	84·84	76·53	82·13	78·99	86·33	89·39	87·33

The difference in weight of the land service and naval service common shells for 10-inch guns, is occasioned by the difference in the thickness of metal in the two shells, the naval shell being 1·35 and the land-service shell 1·646 in thickness. The limits in measurement practically govern the limits in

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in weight, and the Committee applied to the Superintendent Royal Laboratories to know whether he saw any objection to reduce these limits so that the weights of the 10-inch shells (which it will be observed by the Table vary very much in each description) might be more uniform; but that officer has stated, that these limits cannot be reduced without materially increasing the cost of the shells.

The hollow shot for both services are now the respective common shells plugged.

The bursting charge for the naval 10-inch shell is 6 lbs. 4 oz., and for the land service shell 5 lbs.

The average weight of the 10-inch naval shell with bottom and rivet is about 81 lbs, adding the bursting powder 6 lbs. 4 oz., gives 87¼ lbs., which is little in excess of the weight (86 lbs.) it appears to have been intended originally should be the limit.

The average weight of the 10-inch common shell with bottom and rivet for land service is about 88½ lbs., adding the bursting charge 5 lbs. gives 93½ lbs., being 7½ lbs. in excess of the original projectile, and exceeding the weight of the naval shell by 6¼ lbs. No diaphragm shell for 10-inch guns has been sanctioned, so far as the Committee are aware; indeed the 10-inch guns are not calculated for the use of so heavy a projectile.

The Committee having carefully considered the subject of the weight of 10-inch shells, as affecting both the gun and carriage, we beg leave to recommend that 10-inch shells, both for land and naval service, be made of the same thickness, viz., 1·35.

The patterns cannot be assimilated on account of the difference in size of the fuze-holes.

The 10-inch shells for use from mortars, the Committee recommend should still remain of the present thickness, viz., 1·646.

With reference to the present store of land service common 10-inch shells, the Committee recommend, that all exceeding 84 lbs. in weight be put aside as unfit for use with 10-inch guns.

The Committee will report in a few days, whether the shells weighing over 84 lbs. can be made available as mortar shells.

(signed) *J. St. George.*

(75.12.790.)

Horse Guards, S.W.
Sir, 5 November 1860.

In reply to the War Office letters of the 1st instant, I am commanded by His Royal Highness the General Commanding in Chief, to express his concurrence in the recommendation of the Ordnance Select Committee, that the 10-inch shells for the land and naval services should henceforth be made of a uniform thickness; viz., 1·35 inches.

With reference to the Report, No. 1208 of the Select Committee, His Royal Highness has called upon the officers commanding Royal Artillery at the stations named below to ascertain, by actual experiment, the weight of 20 10-inch shells, empty and without bottoms, taken at random from the stores under their charge. The following table shows the weights:—

STATION.	Maximum.	Minimum.	Average.
Devonport - - -	89·0	86·8	87·8
Sheerness - - -	89·15	87·0	88·8
Portsmouth - - -	89·4	86·0	87·8
Dover - - - -	90·2	86·2	87·9
Leith Fort - - -	82·10½	77·9½	79·0
Guernsey - - -	88·4	86·4	87·5
Manchester - - -	89·0	85·10	87·4

This examination has shown a result which much surprises his Royal Highness that any officer in charge of a manufacturing department should take upon himself to alter the weights of shells without any authority whatever.

The authorised shell for the 10-inch gun should weigh 88½ lbs. filled, whereas the shell issued to the Royal Artillery in reality weighs about 93 lbs when filled.

This difference is one of very serious consequence, as not only tending to cause an undue strain upon the gun and its carriage (as pointed out by Lieut.-Col. Clerk R. A.) but absolutely endangering the lives of the gun detachment, who are unaware that they are firing a shell not sanctioned by authority, and which the gun was never constructed to bear.

I am, therefore, commanded by his Royal Highness to express his opinion that these shells would never have been issued for use had they been subjected to the ordeal of proof by the Inspector of Artillery; and his Royal Highness is further of opinion, that the manufacturer of any article of equipment should not be the person to "pass" the same for the service. I am, therefore, to suggest that all projectiles, &c. should be examined and passed by the Inspector of Artillery.

In the suggestion of the Ordnance Select Committee, that all 10-inch shells exceeding 84 lbs. in weight, should be put aside as unfit for use with 10-inch guns, his Royal Highness entirely concurs, although the effect of this will be to condemn nearly the whole supply of 10-inch shells now in charge of the Royal Artillery. Should Mr. Secretary Herbert approve, the necessary directions shall be given accordingly. Lieut.-Colonel Clerk's report is herewith returned, as requested.

I am, &c.
(signed) *Chas. Bingham*, D. A. G.

The Under Secretary of State for War,
War Office, Pall Mall.

Copy of a Minute of Colonel *St. George*, R.A. C.B.

8. 11.

The Commander in Chief concurs, and as it is a change of store material, the director of stores should see the papers now, but I pass them to you as

as requested. With regard to the latter part of the letters, suggesting that all projectiles should be examined and passed by the inspector of artillery, I concur in the opinion of his Royal Highness.

(signed) *J. St. George.*

Sir B. Hawes.

Copy of a Minute of Sir *Benjamin Hawes* with reference to the above.

8. 11.

"I AGREE with Colonel St. George, especially as we are now entering upon a new manufacture of a very nice and delicate description; viz., the projectiles for Armstrong guns. In them there should be no variation unsanctioned. We take great pains to secure the gun being of the sealed pattern and properly proved. This will be unavailing if any variation take place in the projectiles; it is a very important question, and I cannot but think we should have an inspection (for the present at least) of the projectiles, wholly independent of the laboratory inspection.

(signed) *B. Hawes.*

Mr. Herbert.

Copy of Report of the Ordnance Select Committee as to whether 10-inch Shells, weighing over 84 lbs., can be made available for Mortar Shells.

(Committee Minute, No. 4700, 23/8/61.—Report No. 1801).

24 August 1861.

THE Committee have the honour to report, with reference to the last paragraph of their Report, No. 1208, Minute 2477, that they have ascertained from the Superintendent of the Royal Laboratory, that 10-inch land service common shells, weighing over 84 lbs., cannot be made available as mortar shells, owing to the difficulty of making the Lewis holes, which are necessary in shells fired from mortars. The Committee beg to point out, that the delay in furnishing this Report has arisen from their having been obliged to wait for the results of certain experiments which the Superintendent of the Royal Laboratory proposed to carry out in order to ascertain whether their shells could or could not be conveniently adapted for use as mortar shells, but which were not communicated to the Committee until the 21st instant, owing, as stated by Lieutenant-Colonel Boxer, to the pressure of business in his department, which caused the subject to be lost sight of.

(signed) *W. Wiseman.*

MEMORANDUM for Ordnance Select Committee.

With reference to Colonel Lefroy's, of the 1st instant. Minute 2477.

Royal Laboratory, Woolwich,
21 August 1861.

EXPERIMENTS to ascertain whether the 10-inch land service common shell could be made available as mortar shells were made in this department some time since, but pressure of other matters caused the subject to be lost sight of. The result of the experiments led to the conclusion that the 10-inch common shell could not be conveniently adapted for use as mortar shells at foreign and out-stations, the difficulty being to make the Lewis holes, which are necessary in shells fired from mortars.

(signed) *G. M. Boxer,*
Supt. Royal Laboratory.

War Office,
9 Sept. 1861.

WITH reference to your letter of the 5th November last, expressing the concurrence of H.R.H. the General Commanding in Chief with the opinion of the Ordnance Select Committee, that 10-inch land service common shells, weighing over 84 lbs., should be laid aside as unfit for use with 10-inch guns, the Secretary of State requests that instructions be given accordingly (if not already issued), and that a list be forwarded to this office, as early as convenient, stating the number thus laid aside and required to be replaced at each station.

The question of the disposal of these shells is still under consideration.

(signed) *Alex. T. Tulloch,*
Director of Ordnance.

The Deputy Adjutant General, R.A.

3/4/62.

WITH reference to your Minute 10/3/62, on 75/12/1345, see 75/12/1105; and be so good as to explain the difference of opinion with regard to the conversion of 10-inch land service common shells into mortar shells; and if, from any recent experiments, you have discovered that such an operation can be conveniently performed, will you report whether you now consider that all the 10-inch common shells, land service, which have been issued above the authorised weight, can be converted at the stations where they now are.

(signed) *A. T. T.*

5/4/62.

THE common 10-inch shells, which are above the present authorised weight, can be readily converted in this department to be used with mortars.

The work, however, cannot be done at the out-stations, unless suitable machinery is supplied.

(signed) *E. M. Boxer.*

Director of Ordnance.

App. No. 3.

7/4/62.

You have not explained the reason for changing your opinion regarding the conversion of the 10-inch shell, common land service, which are found to exceed the authorised weight into mortar shells. Will you state?

A. T. T.

Superintendent Royal Laboratory.

11/4.

I have not in the least changed my opinion as regards the matter in question. In my memorandum to the Ordnance Select Committee of 21st August last, I stated as follows:—"The result of the experiments (made in Royal Laboratory) led to the conclusion that the 10-inch common shells could not be conveniently adapted for use as mortar shells at foreign and out-stations, the difficulty being to make the Lewis holes, which are necessary in shells fired from mortars." This is my opinion still; although as stated in my previous Minute hereon, the shells can be readily converted in this department. I would suggest that, in future, when my opinion is asked for by the Ordnance Select Committee, my memorandum on the subject should accompany the Committee's Report, instead of being embodied in it, in order that my views on any matter on which I express an opinion may be clearly brought to the notice of the Secretary of State.

E. M. B.

Director of Ordnance.

10-inch Common Shells.

With reference to War Office Circular of the 20th and 21st July 1862, six thousand six hundred and nine (6609) have been reported from Gibraltar and Corfu as exceeding 85 lbs. in weight, and four thousand six hundred and eight-eight (4,688) have been received at Woolwich from home stations as exceeding 85 lbs. in weight.*

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* *Vide* page 261 of Report from Select Committee on Ordnance, 1862.

Appendix, No. 4.

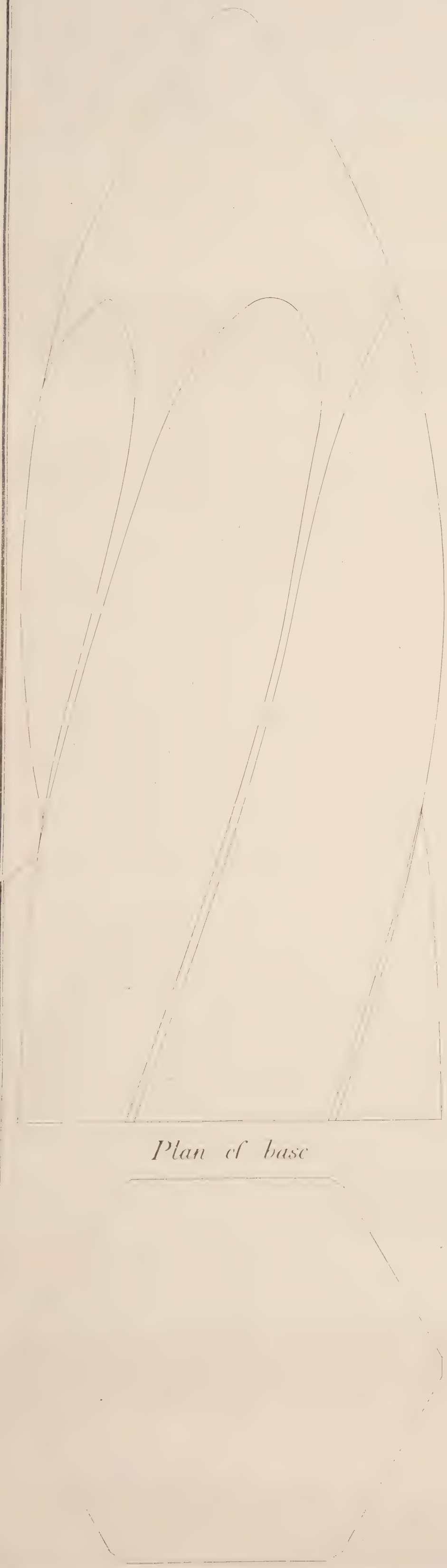
App. No. 4.

Drawing delivered in by Captain Sir William Wiseman, Bart., R.N., 19 March 1863.—

(*See opposite.*)

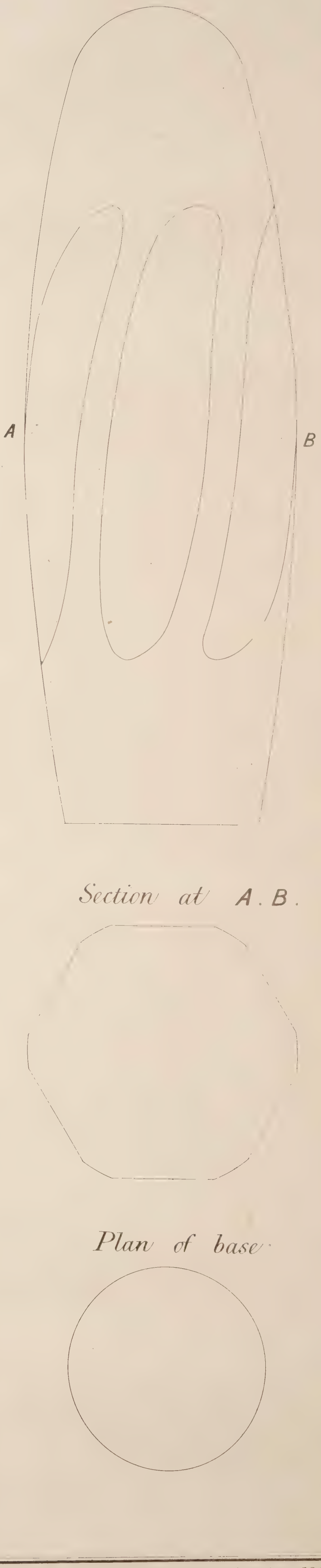
WHITWORTH PROJECTILES (FULL SIZE)

Hollow Shot fired in 1856 from a 24 Pr. How^r. block, 12 Por. bore



Plan of base

12 Pr. Solid Shot fired from 12 Pr. B.L. Gun



Section at A.B.

Plan of base

N°. 487. Ordered, by The House of Commons, to be Printed, 23 July, 1863.
Henry Hansard, Printer.

Appendix, No. 5.

PAPERS relating to Mr. *Whitworth's* Assertions in Letters to the "Times," dated 11 October and 8 November 1862, in regard to the Construction of his 7-inch Gun.

ORDNANCE SELECT COMMITTEE.

(Committee Minute, No. 7834. 21/11/62.—Report, No. 2586, 1st December 1862.)

PRESENT:

Brigadier-General St. George, C.B., R.A.
Captain Sir. W. Wiseman, Bart., R.N.
Brevet-Colonel Hogge, C.B., R.A.
Brevet-Colonel F. Campbell, R.A.
Lieutenant-Colonel R. S. Baynes, Unatt.
Lieutenant-Colonel Gallwey, R.E.
Brevet-Colonel Lefroy, R.A., Secretary.

SUBJECT:—Mr. Whitworth's assertions, in letters of the "Times," dated 11th October and 8th November 1862.

(With reference to W. O. Minute, 18/11/62, on 80—W—701.)

COMMITTEE'S REPORT.

THE Committee are instructed to report, for the information of the Secretary of State, whether the assertions recently put forward by Mr. Whitworth in the "Times" newspaper, relative to the construction of his 7-inch gun, are borne out by the facts of the case, and they have been furnished with copies of the correspondence which passed between the Whitworth Ordnance Company and the Assistant Superintendent, Royal Gun Factories, in reference to the manufacture of that gun.

Mr. Whitworth, in his letter to the "Times," dated 11th October, says, "It should, perhaps, be explained that my 7-inch gun was made at Woolwich, in consequence of arrangements decided upon after Lord Palmerston and Sir Cornewall Lewis had witnessed trials of my 70-pounder at Shoeburyness, about 12 months ago; not having the means of constructing so large a gun at Manchester, I requested to be allowed to have it done at Woolwich. This was done under the efficient superintendence of Mr. Anderson, according to drawings supplied by myself. The gun differs in construction from the rifle guns of the service: its metal is differently distributed, its form is different, and it has a fixed breech, being a muzzle-loader." He repeats this statement in his letter of November 8th: "For the ready and able assistance afforded me by Mr. Anderson in the manufacture of my gun at Woolwich, I have already expressed my thanks; but it is only due to myself to state that the gun, besides being rifled on my system, was made to drawings supplied by me." Such being Mr. Whitworth's assertions, it is with unfeigned astonishment that the Committee have to report to the Secretary of State that they are not only not borne out by the facts of the case, but that they are the reverse of the truth; and they are at a loss to understand how a gentleman of Mr. Whitworth's reputation could hazard them. It is the more difficult to suppose that they were made through inadvertence, because Mr. Whitworth has not corrected them in either of the two subsequent letters to the "Times," (November 12 and 18), one of which was also subsequent to an article in the "London Review," (November 15), in which their accuracy was called in question. App. No. 5.

The facts established by the correspondence placed before the Committee are these: some time between the 13th and 24th December 1861, Mr. Halse (Mr. Whitworth's partner), waited on Mr. Anderson, Assistant Superintendent, Royal Gun Factories, and left with him some tracings of the proposed 7-inch gun. Mr. Anderson returned four of these tracings on 24th December, accompanied by a drawing of his own, W—82, showing an amended build of muzzle-loading gun, which he preferred. The Whitworth Ordnance Company, on the 26th December, by letter, of which a copy is annexed, entirely accept this amended design, stating that Mr. Whitworth has just returned from Derbyshire, and has seen the tracing W—82, showing the construction proposed for the 7-inch gun to be made at Woolwich, and rifled on Mr. Whitworth's principle. * * * We will avail ourselves of your offer to undertake the responsibility, and to leave the details of construction entirely to yourself; we may, however, ask you to consider the propriety of omitting the outside hoop, shown on tracing W—82, and welding the next series of hoops together, so as to avoid the joints; this would reduce the weight of the gun to about seven tons."

In reply to this, Mr. Anderson, on 31st December, transmitted another drawing, W—87, showing the 7-inch muzzle-loading gun slightly altered in the exterior diameter, but retaining the exterior coil. This drawing was returned to him on the 3d January, signed by Mr. Whitworth, as an authority for proceeding with the manufacture of the gun.

There was some subsequent correspondence about details connected with the sighting, &c., from which it is only necessary to quote one paragraph to prove how entirely they were left to the Assistant Superintendent, Royal Gun Factories: "The vent hole we will leave entirely to you. If you think it better not to vent before proof, please carry it out; or if you prefer to vent

App. No. 5.

before proof, and to copper bouch the hole after, you will oblige us by doing so," (1st April 1862).

It may, however, be asked, whether the drawing W—87, ultimately approved and signed by Mr. Whitworth, differed so far from his own original drawing as to constitute a different design.

The Committee must reply that it differed as much as one drawing can well differ from another in such a matter.

The Manchester drawing represents a gun 28 inches in diameter at the breech, cylindrical to beyond the trunnions, built up of 22 coils, surrounding an inner tube bored through, and closed by a breech plug, cut to three diameters in steps, with three different male screws to engage as many layers of coil.

The Royal Gun Factories drawing represents a gun 31 inches in diameter at the breech, and 28 inches at the trunnions, built up of 9 coils surrounding an interior of three component parts, viz. an inner tube not bored through, a breech block over this tube, a long coil from the breech block to the muzzle, and a cuscible or breech piece behind the inner tube, with only one thread upon it engaging the breech block alone.

Its metal is not differently distributed from that of the service guns, and its form is not different in any degree worth notice.

Whatever success may attend Mr. Whitworth's system of rifling in this gun, the Committee are bound to say that so far as that success turns upon the strength of the gun, and the use of very large charges, it is due to the Royal Gun Factories alone. It only remains to say, that although Mr. Whitworth challenges the originality of Sir William Armstrong's coil system of construction, it is at least as much original as the polygonal system of rifling. The Committee possess an hexagonally bored rifle, dated Enfield 1843; the more modern and perfect development of the system is known to have originated with the late Mr. Brunel; the mechanical skill of Mr. Whitworth has made it his own by more perfect execution and numerous improvements of detail. In like manner, suggestions to employ coils or ribbons of iron in the manufacture of guns can be traced back long antecedently to the actual introduction of the system; two cases of this are quoted by Mr. Mallet in his work on the "Physical conditions involved in the construction of artillery," page 197 (1813 and 1830); but to Sir W. Armstrong is undoubtedly due the distinction of having overcome the difficulties of reducing this mode of manufacture to practice, and shown its applicability to the largest constructions.

It is as much a characteristic of the Armstrong gun as the system of breech loading, or the mode of rifling.

The Committee find that this is not the first occasion on which Mr. Whitworth has had recourse to the coiled system.

The 70-pounder gun now at Shoeburyness, experimental No. 102, has two coils applied in the Royal Gun Factories, and there are two other 70-pounders, Nos. 106-7, which were entirely made there, in order that Mr. Whitworth might try the systems, and in consequence of the acknowledged inability of the manufacturers of homogeneous iron last year, to produce that material of proper quality in large sizes.

This will appear by the letter of the Whitworth Ordnance Company, dated 2d May 1861; and Mr. Whitworth's letter of 15th May 1861, which are subjoined, and constitute in the Committee's opinion a very substantial obligation to Sir William Armstrong's manufacturing skill.

(signed) *J. St. George*,
President.

Sackville-street, Manchester,
Sir, 26 December 1861.

We are in receipt of your favour of the 24th instant, and beg to inform you that Mr. Whitworth has just returned from Derbyshire, and has seen the tracing, No. W—82, showing the construction proposed for the 7-inch gun to be made at Woolwich, and rifled on Mr. Whitworth's principle.

Considering that the mode of construction which Mr. Whitworth would have preferred, and which we have explained to you, cannot, with the facilities now existing at Woolwich, be conveniently carried out, we will avail ourselves of your offer to undertake the responsibility, and to leave the details of construction entirely to yourself. We may, however, ask you to consider the propriety of omitting the outside hoop shown on tracing W—82, and welding the next series of hoops together, so as to avoid the joints; this would reduce the weight of gun to about seven tons.

We venture to express a hope that the gun may be proceeded with, with all possible despatch.

We are glad to hear from Mr. Hulse that we are likely soon to receive the brass gun blocks, and beg to ask you to send the sights with them.

We have, &c.
(signed) *The Whitworth Ordnance Company.*
The Assistant Superintendent, R. G. F.

Sir, Fenton's Hotel, 15 May 1861.

I beg to acknowledge the receipt of your letter of 13th May, 80 P—W, No. 442. It appears to me that some misapprehension exists as to the nature of the request made by my firm; I am desirous of trying my principle of rifling with large guns made on the coil system; this has not yet been done; the Whitworth guns lately tried at Woolwich were all made with inner tubes of homogeneous iron. I was supplied from Woolwich with outer hoops of coiled iron for two guns, to these I wish to apply two coiled tubes inner, without which the application of my system of rifling to the coiled guns cannot be fairly tested. With this object, I should be obliged if I could be supplied with two coiled inner tubes, not two complete guns, from the Royal Arsenal.

I have, &c.
(signed) *Joseph Whitworth.*
The Under Secretary of State for War.

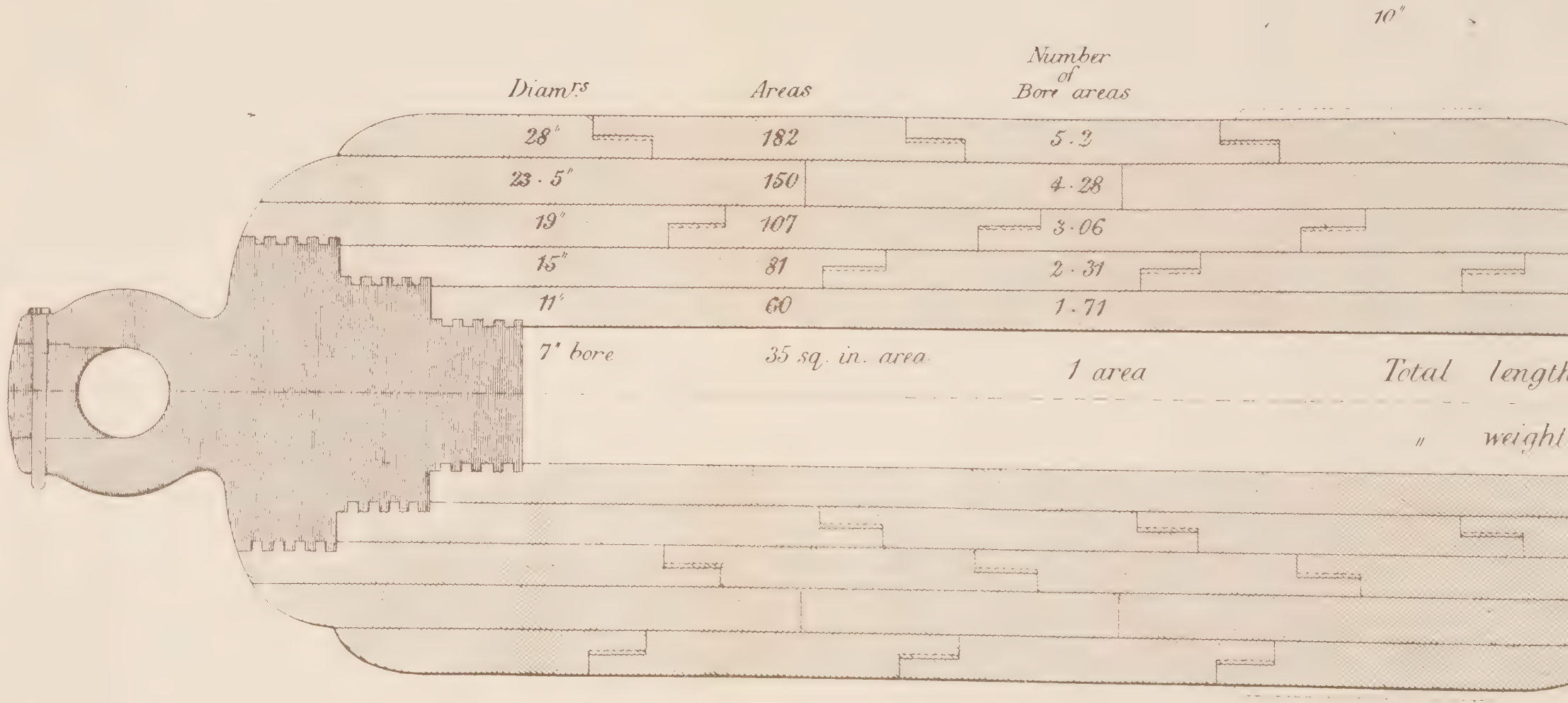
Charlton-street, Portland-street,
Sir, 2 May 186[illegible].

We beg to acknowledge your letter 80 P—W —457, dated 27 April, giving us authority to receive back the gun (No. 83) supplied by us.

From the results of the proof trials with this gun,

JOSEPH WHITWORTH & Co

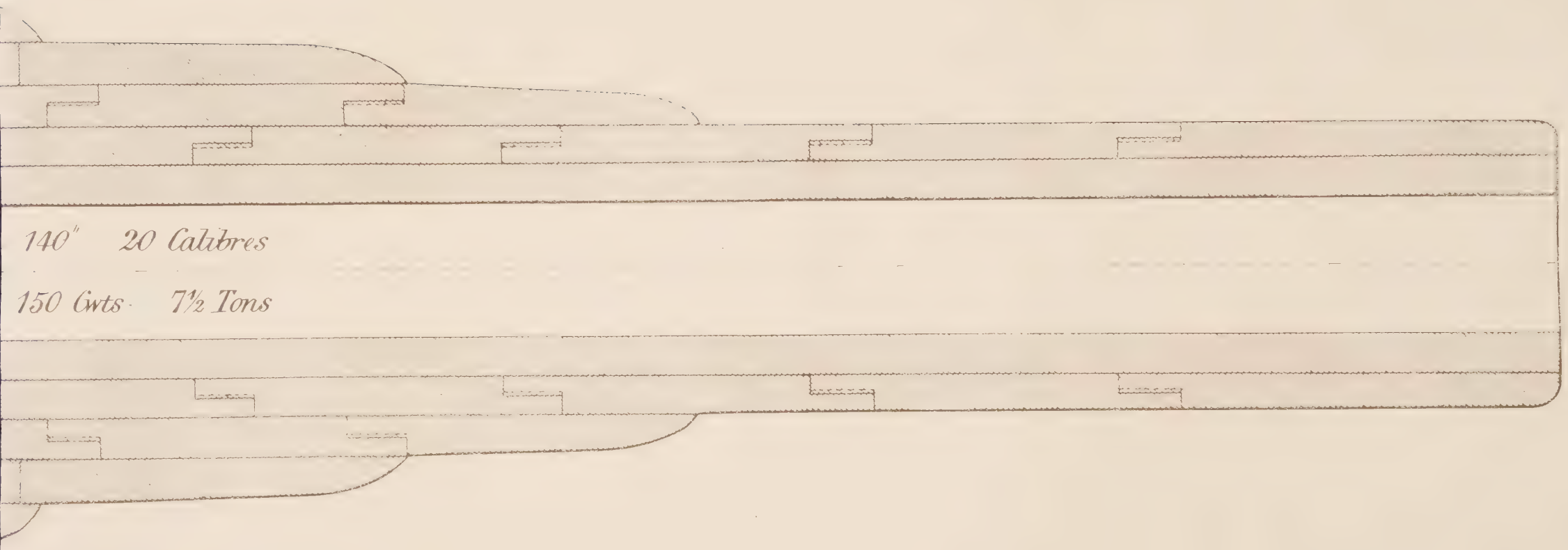
MANCHESTER.



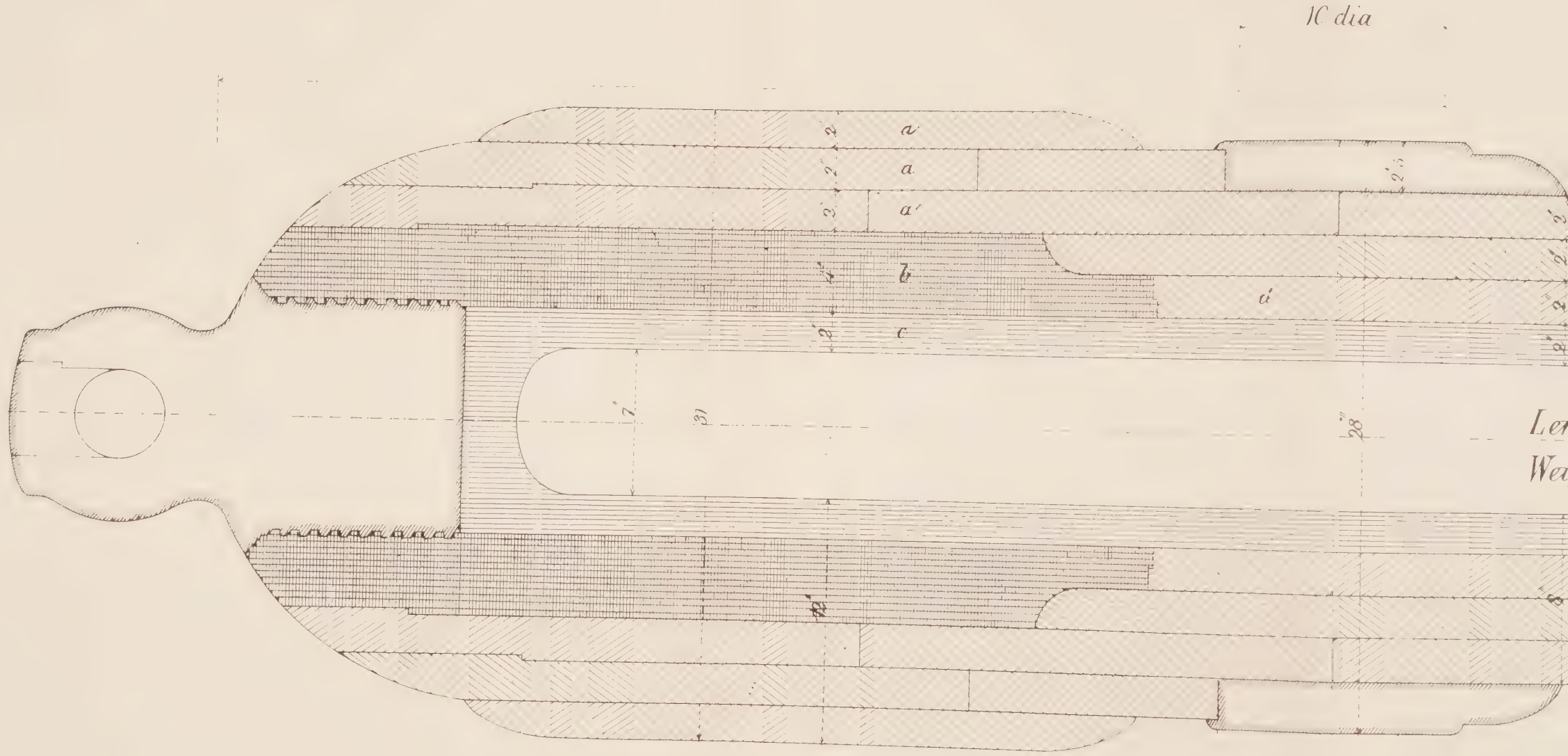
Nº 1.

MUZZLE LOADING GUN.

SCALE ¾ INCH = 5 INCHES.



Nº 487. Ordered, by The House of Commons, to be Printed, 23 July 1863.
Henry Hansard, Printer.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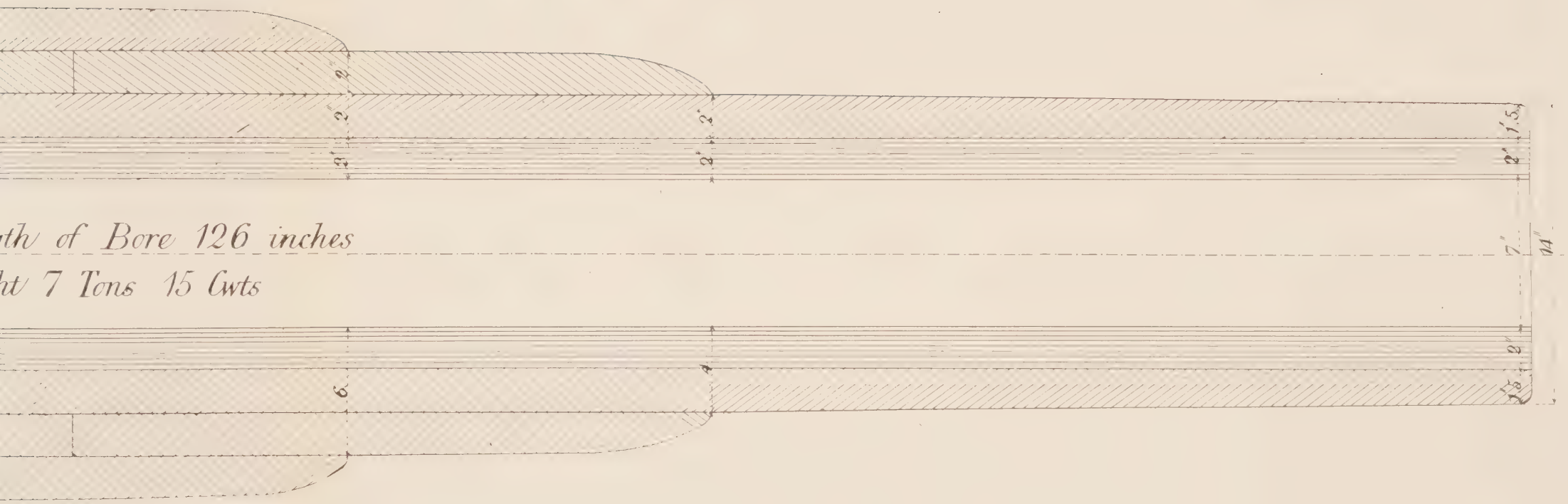
We

Nº2.

7 INCH MUZZLE LOADING GUN

SCALE 1⅝ INCH TO 1 FOOT

140 inches



th of Bore 126 inches

ht 7 Tons 15 Cwts

JOSEPH WHITWORTH & Cº

MANCHESTER

Nº 487. Ordered, by The House of Commons, to be Printed 23 July 1863.

Henry Hansard, Printer.

gun, it would appear that the homogeneous metal cannot always be depended upon for large barrels until arrangements can be made for insuring that they are perfectly annealed. Such arrangements we have already carried out for smaller barrels made of the same material, and we get them when over-strained to enlarge or bulge, and not to burst.

At present the homogeneous metal we use for large cannons is necessarily annealed by the makers of the metal, who have not got the proper heating furnaces for the purpose, and we regret to say that it has not been so regular and uniform as we expected, and as it would be if properly annealed.

We therefore should feel obliged if two barrels made on the coiled system might be supplied to us from the Royal Gun Factory, Woolwich, in a rough bored and turned state, which we would rifle and finish, and return with the least possible delay.

If our proposition is acceded to, we shall be glad to be put in communication with the Superintendent of the Royal Gun Factory, and to furnish all the information respecting the dimensions and particulars of the barrels that may be required.

We are, &c.
(signed) *Joseph Whitworth & Co.*

The Under Secretary of State,
War Office, Pall Mall.

EXTRACT from "The London Review," 15th November 1862.

Whose is Mr. Whitworth's Gun?

THE country is to be congratulated on the important achievements in artillery which have been effected during the last year. Guns are once more in the ascendant, and the believers in iron-plates have reason to be proportionately downcast. The experiments of last Thursday are not certainly final, and the best artillerists agree that finality is as unphilosophical a term when applied to cannon as it is with regard to all other sciences. The only people who can complain of want of finality are those who pay taxes, and the public has made up its mind not to consider money ill spent which is spent upon investigating the powers of guns and of projectiles. We should congratulate Mr. Whitworth himself more heartily on the results achieved by the gun built for him on Sir William Armstrong's principle and rifled on his own, had he not shown, in his recent letters in the "Times," a desire to monopolize the whole credit of the weapon. It seems that the mouth of his rival, Sir William Armstrong, is closed upon the subject; but that is no reason why justice should not be done to him. The gun which distinguished itself the day before yesterday is nothing more or less than an Armstrong gun, constructed at Woolwich, with coils, and rifled by Mr. Whitworth. This fact the latter gentleman has attempted to extenuate and explain away, if not altogether to conceal. It would be disagreeable to see anything like personality creep into a correspondence between two such eminent scientific men; and it would be still more to be regretted if symptoms of a disposition to appropriate one another's laurels should show themselves in the course of what should be an honourable rivalry.

Mr. Whitworth's disclaimer of all obligation to Sir William Armstrong must have taken a good many by surprise. We ourselves had considered the respective claims of the two inventors to a share in the last combination—which might be called the Armstrong-Whitworth gun—tolerably settled. Sir William Armstrong, as we thought, had made the gun and his rival had rifled it. Both deserve praise, and nobody but a partizan would wish to detract from the fair fame of either. In his first letter, Mr. Whitworth certainly implied that he had only used so much of the coil system as he had a clear right to use; and, secondly, that the coil system itself did not of right belong to Sir William Armstrong. He has suggested, subsequently, that a certain inner tube in his new gun is made upon a plan of his own—which may be distinguished from that on which the Armstrong inner tube is built; and in his last note he distinctly avers that his gun was made according to drawings supplied by himself to Mr. Anderson, who is at the head of the Armstrong-gun department at the Royal Gun Factory at Woolwich. App. No. 5.

We have not the faintest wish to exalt Sir William Armstrong at the expense of Mr. Whitworth; but after some examination we are of opinion that Mr. Whitworth's assertions cannot be supported; and that he has exposed himself to a serious suspicion, if not of a *suppressio veri*, at least of an ungenerous attempt to overpaint his own part in the performance. The truth, as we have reason to know, is this. Mr. Whitworth in the first instance forwarded a drawing of a proposed coil-gun to Mr. Anderson, a gentleman owing to whose ability in a great measure the Woolwich Gun Factory has been placed on its present footing. Mr. Anderson returned the papers, intimating that there were serious difficulties in the way of building a gun of the kind; and forwarding a new and improved drawing of his own, in which the Woolwich system was embodied; requesting at the same time that Mr. Whitworth, if he approved of the proposed design, would sign it and return it. The design of Mr. Anderson was signed by Mr. Whitworth and returned accordingly to the author, who, we believe, was given *carte blanche* by Mr. Whitworth in the matter. The gun was made, not as Mr. Whitworth writes, "to drawings supplied by me," but "to drawings supplied" to him by the officers of the Armstrong gun department. Both of the "drawings" to which we have alluded are no doubt still extant. We presume the correspondence between Mr. Whitworth and the Gun Factory is extant too; and a production of the originals will at once show whether the statement of Mr. Whitworth or our counter-statement is correct.

Lest it should be thought that we are doing Mr. Whitworth injustice, we beg to refer him and our readers to some very important evidence, as to the use he has made of the coil system, given last July by General St. George, C.B., and Colonel Lefroy, the president and secretary of the Ordnance Committee, before a Select Committee of the House of Commons. The authority of any evidence these able and impartial officers have given on such a subject, even Mr. Whitworth will not venture to dispute, nor indeed was any attempt made to shake it at the time. It refers to the now well-known seven-inch gun, to which Mr. Whitworth has given his name:—

App. No. 5.

Evidence of Colonel *Lefroy* (p. 16).

334. By Sir John Hay: Was the Whitworth gun that you have described as being 67 cwt., heavier than the Armstrong gun, made on the Armstrong coil principle?

Colonel Lefroy: Yes.

336. But the Armstrong coil principle is adopted by other makers for the purpose of strengthening their guns, is it not?

Colonel Lefroy: I do not know of any other instance.

Evidence of General *St. George* (p. 136).

2801. By Mr. Baring: You said just now, that when it came to standing large charges of powder, Mr. Whitworth has had his gun made on Sir William Armstrong's principle in the Royal Gun Factory?

General St. George: Mr. Whitworth first made his gun, using what he called homogeneous iron, and finding that that did not answer for large guns, he has now had them made on the coil principle in the Royal Gun Factory.

2804. By Mr. Laird: With reference to the gun which is now making at Woolwich, upon Sir William Armstrong's principle, for Mr. Whitworth, how is that being made?

General St. George: It is being made on the coil principle of Sir William Armstrong.

2805. Is that the one which he took out a patent for?

General St. George: Yes; Sir William Armstrong patented it.

Blue Book, 25th July 1862.

According to General St. George and Colonel Lefroy, it is as we had thought. Mr. Whitworth, however, draws a distinction between the make of the Armstrong gun and his own, which we are bound to say does not appear to us worthy of himself. He tells us, that if Sir William Armstrong will state in what Mr. Whitworth is indebted to him, he will be glad to acknowledge his obligations. Sir William, he continues, "probably supposes that my inner tube, like that of his gun, is made of welded coiled bars. This is not the case: it is formed of a solid bar, bored out; a construction of which, I believe, he does not approve." If words mean anything, Mr. Whitworth here implies, though he is careful not to assert, that the "solid bar" is an invention or addition of his own. It would have been more candid to have stated openly, that though Sir William Armstrong now disapproves of the "solid bar," it is not on that account less the property of Sir William Armstrong. Till lately, the large Woolwich guns all had it. Recently, it has been discarded for a newer pattern. This proves, not that Mr. Whitworth has not borrowed, but merely that he has chosen to abstain from borrowing from the "last thing out."

Into the vexed question of originality of ideas we do not care to enter. The "coil" system was certainly introduced by the then Mr. Armstrong, at a time when it was a novelty to the public; the nearest approach to it being the inferior, though somewhat ingenious, "hoop" system belonging to Captain Blakeley. Whether in all past time the idea ever occurred to anybody else is a problem which is probably insoluble. The idea of coils of iron, like many other happy ideas, seems so simple, now that it has been thought of, that it is easy to suggest that it must have been struck out before; though, as a matter of fact, we rather fancy no one had ever dreamt of applying it to cannon, the mechanical difficulties of forging and welding being seemingly insurmountable. It was reserved for Sir William Armstrong to surmount them, if we are wrong even in supposing that he originated the idea altogether. The merit belongs, in these mechanical discoveries, to those who can use them, not merely to those who can imagine them. It is interesting to know that the very polygonal system of rifling to which Mr. Whitworth has given such prominence is not his own, but sprang in all probability from the fertile genius of Brunel. Even Mr. Brunel was frustrated in the conception. At Woolwich may be seen a very ancient rifle of the 17th century constructed and rifled on the polygonal plan. At all events many years ago Mr. Brunel had a gun made for him by Mr. Westley Richards, and rifled polygonally. When Mr. Whitworth set up his rifle gallery at Manchester for the Government experiments with small arms, Mr. Brunel lent him the rifle to be tried against the rest. Mr. Whitworth, we believe, afterwards adopted it, and applied the polygonal system with success to cannon. This does not diminish his credit for industry and genius. Mr. Whitworth would think it rather strange if Sir William Armstrong adopted the Whitworth groove, and justified himself on the ground that it had in the first instance been suggested by Mr. Brunel. It is unscientific and undesirable to enter on such trivialities. The labourer, far more than the mere dreamer, is worthy of his hire; and it would not detract from the merit of either Sir William or Mr. Whitworth, should it turn out that they have not been the sole proprietors of their own luminous designs. We need hardly say that we have no bias in favour of any gun above another. Let the best gun win. There is, it seems, to be a formal trial; we do not propose to anticipate its result, but it is only common sense to acknowledge that even if Mr. Whitworth's latest guns are better than all others, a large portion of the praise is due to the author of the coil system; in fact, we believe the coil system is henceforward a necessity for all heavy ordnance, at all events for many years to come.

Appendix, No. 6.

11 March 1863.

RETURN from Her Majesty' Ship "CAMBRIDGE," of the TRIALS of Sir WILLIAM ARMSTRONG'S RIFLED ORDNANCE. App. No. 6.

EXPLANATION SHEET.

Under the heading "Fuzes" - - - T. stands for Time.
" - - - C. " for Concussion.
" - - - P. " for Percussion.

Under the heading "State of Weather."	Under the heading "Force of Wind."
B.—Denotes Blue Sky.	0.—Denotes Calm.
C.—Cloudy.	1.—Light Air.
D.—Drizzling Rain.	2.—Light Breeze.
F.—Fog.	3.—Gentle Breeze.
M.—Misty.	4.—Moderate Breeze.
P.—Passing Showers.	5.—Fresh Breeze.
Q.—Squally.	6.—Strong Breeze.
R.—Rain.	7.—Moderate Gale.

The experiments down to 1st May 1862, were carried on under the direction of Captain A. W. Jerningham, after that date, under the direction of Captain L. G. Heath, C.B.

SCHEDULE of REPORTS and LETTERS founded upon the following Details of Experimental Firing.

No.			Page
1.	13 July -	1860. Armstrong 12-pounder - - - - - - -	320
2.	16 November	1860. " 40-pounder - - - - - -	320
3.	6 February	1861. " 25-pounder (boat's gun) - - - -	323
4.	16 February	1861. Stripping of Armstrong projectiles - - - -	325
5.	28 March -	1861. On greased wads - - - - - - - -	325
6.	21 May -	1861. On a shortened 12-pounder Armstrong gun - -	326
7.	19 September	1861. Improved gun carriage for 20-pounder Armstrong -	326
8.	6 May -	1862. 9-pounder, reduced from a 12-pounder Armstrong -	326
9.	23 February	1863. Carriage for 110-pounder, fitted with cast-iron flanges instead of wrought-iron straps - - - - - - - - -	327

Her Majesty's Ship "Cambridge,"
Devonport, 11 March 1863.

L. G. Heath, Captain.

RETURN from the "Cambridge" of Trials of RIFLED ORDNANCE since 1 January 1858.—Target was the Shagrock off the Breakwater.

DATE.	Rounds. Shot.	Rounds. Shell.	Fuzes. T.	Fuzes. C.	Fuzes. P.	Distance of Target.	Nature of Wads, &c.	Force of Wind.	State of Weather.	REMARKS.	Name and Rank of Officer Superintending.
						Yards.		✦			
12-POUNDER ARMSTRONG; Weight 8½ Cwt.											
Between 4 May 1860 and 19 February 1861, 1,132 rounds were fired from 12-pounder Armstrong Guns, but no record appears on this ship's books of the particulars.											
Fired from the "Redwing" gunboat under weigh.											
19 Feb. 1861	6	–	–	–	–	2,000 to 2,300	greased	–	–	Heavy sea and high water; could not see the rock very distinctly	—
25 Feb. „	12	10	10	10	–	750 to 2,700	sponge	–	–	Could not elevate gun sufficiently at distant object when the vessel was upright without unshipping rear chock of slide. (This was a boat's slide and carriage.)	—
26 Feb. „	19	–	–	–	–	700 to 2,000	ditto	–			
4 March „	11	11	11	11	–	400 to 2,100	ditto	–	–		
6 March „	18	–	–	–	–	2,000 to 2,700	ditto	4 to 6	C.		Hy. Nicholson, Lieut.
11 March „	14	–	–	–	–	1,900 to 2,500	ditto	7	Q.	Refaced this gun the first time on the 8th March 1861, after firing 509 rounds.	
12 March „	27	–	–	–	–	2,000 to 2,900	ditto	8	Q. P.		Hy. Nicholson, Lieut.
18 March „	29	3	3	3	–	1,900 to 2,300	ditto	4	Q. R.		
25 March „	13	4	4	4	–	1,300 to 2,600	lubricating	1	B. C.	Seventeen charges, with wads attached, were fired; they did not appear to leave more fouling in the rifling than wads used separately; but the major part of the wads, instead of melting and lubricating the bore, was blown out in large pieces.	ditto.
2 April „	7	1	1	1	–	2,700	ditto	1	B. C.	Eight charges with wads attached were fired, with results similar to those stated above. Refaced for second time, 5th April 1861, 98 rounds having been fired since last refaced.	ditto.
8 April „	3	6	6	6	–	900 to 2,100	ditto	3	B. C.	The last shell was a premature explosion	W. Dawson, Lieut.
22 April „	8	7	7	7	–	1,000 to 1,500	ditto	3	B. C.	The fourth shell burst about half-way	S. G. Price, Lieut.
29 April „	12	6	6	6	–	500 to 2,000	ditto, attached to charge.	2	B. C.	The last six rounds found difficulty in loading, through fouling; the last shell a premature explosion.	
6 May „	10	–	–	–	–	1,800 to 2,000	lubricating attached.	2	B. C.	At the fourth round could not get the shot home through fouling; fired with half the charge in order to blow the shot out of the gun; the gun was then thoroughly sponged out, and the remainder of the practice carried on with the wads in the cartridge; the gun becoming more foul after each successive round.	ditto.
13 May „	17	2	2	2	–	1,000 to 1,600	*see* Remarks	3	B. C.	First three rounds, wads out of cartridge; from fourth to 11th round, wads in cartridge; the last four rounds, wads out of charge and sponged; third round, gun foul; sponge head came off through tye carrying away; sponged gun out thoroughly; 15th round, gun fouled; sponged thoroughly with new sponge each round.	ditto.
16 May „	30	8	8	8	–	1,200 to 1,400	attached, 23, detached, 15.	2	B. C.	Breech-screw clogged after 20 rounds; found greased wad to answer better attached to cartridge than separate; with careful loading may fire 20 rounds without sponging; fired 23 rounds without sponging, using wads choked in cartridge; no difficulty in loading; washed gun out, fired 15 rounds with loose wads, had to knock two shot back, owing to careless loading; these wads foul the gun considerably more than any other we have used, and require to be carefully placed.	J. P. Jones Parry, Lieutenant.
10 June „	27	–	–	–	–	1,900 to 2,200	detached	3	B. C.	Used a damp sponge after the 20th round	S. G. Price, Lieut.
13 June „	33	–	–	–	–	2,100	lubricating	3	B. C.	The practice from this gun proved to have 10 hits, and a mean range of yards "over" 35 and "under" 32. The 68-pounder which was fired at the same object at the same time, had 19 hits, and mean range of yards "over" 20, and "under" 18.	P. Fitzgerald, Lieutenant.
17 June „	14	6	6	6	–	2,200	detached	4	B. C.	This day, gun was mounted on a top and bottom carriage; appeared to act as well as any other broadside gun; sponged every fourth round.	
5 Aug. „	7	–	–	–	–	2,200 to 2,600	lubricating	4	B. C.		
9 Aug. „	3	–	–	–	–	2,200	ditto	3	B. C.		
23 Aug. „	12	–	–	–	–	2,200 to 2,600	attached	1	B. C.		H. Nicholson, Lieut.
31 Aug. „	6	–	–	–	–	2,100	lubricating	2	B. C.		ditto.
2 Oct. „	11	8	8	8	–	2,200	ditto	1	B.	The crutch for the tube is not in a direct line with the half-cock cleat, which makes it hard to pull.	J. P. Jones Parry, Lieutenant.

9 Oct.	„	–	9	9	9	–	2,300	detached -	2	C.	Gun requires refacing.	
14 Oct.	„	–	20	20	20	–	2,200 to 2,300	attached -	1	B.		
28 Oct.	„	–	18	18	18	–	1,700 to 2,000	9 detached- 9 attached.	2 4	B. C.	Refaced 22d October 1861; practice very good; one shell burst prematurely 150 yards from gunboat.	S. G. Price, Lieutenant.
5 Feb.	1862	21	1	1	1	–	2000 to 2,300	detached -	2	B. C.		
The undermentioned were fired from a fixed battery on shore at Bovisand.												
25 Feb.	1861	13	25	25	25	–	2,400	sponge -	–	–	Hazy and difficult to see the object.	
4 March	„	40	–	–	–	–	2,400	- ditto -	–			
18 March	„	32	–	–	–	–	2,400	- ditto -	4	—		
8 April	„	10	2	–	2	–	2,400	- ditto -	3	B. C.	Refaced second time 25th March 1861, after firing 240 rounds - - - - - - -	William Dawson, Lieutenant.
22 April	„	14	7	4	7	–	2,400	- ditto -	3	B. C.	After firing this day the gun was shifted from Bovisand to Torpoint field, and was not again used.	S. G. Price, Lieutenant.
21 May	„	23	–	–	–	–	1,000 to 2,400	attached -	1	H.	Practice very good, especially considering unevenness of the ground, and dazzling sun on smooth water.	
											Lock so badly placed, that at 6° to get object on correctly, lock had to be let down on vent-piece, the hammer coming on with left shoulder of dispart, and at all times trigger line rather in the way; dry sponged after every four rounds.	J. P. Jones Parry, Lieutenant.
3 Dec.	„	9	5	–	5	–	1,050 to 2,300	lubricating	3	B C.	This day first fired from new battery; found the distance from Shagrock by depression instrument to be 2,300 yards; 6° 15′ elevation appeared to be very good. Eighth round vent-piece blew out; cannot account for this piece blowing out, as the lever was up as taut as it could be, but it was the only round that the vent-piece was not steadied by hand, as the lever was being hove up. Drip pan was blown off to about 10 yards, violence being broken by carrying away one arm of elevating screw; vent-piece was not recovered.	- ditto.
Fired from the Launch.												
20 May	„	13	–	–	–	–	various -	1st and 2d rounds wads attached; remainder, wads only.	–	B. C.	Fired this gun in launch with slide lashed to stem (without fighting bolt); first round thawrt of boat sprung out of place, and caused rear chock to go down between thwarts, letting down rear part of slide. Elevating gear badly fitted, screw handle taking bed after third thread. Recoil of gun not particularly violent; lock placed badly, interferes with sight after 6°.	- ditto.
40-Pounder ARMSTRONG.												
Fired from the "Redwing" gunboat underweigh.												
24 Sept.	1860	32	–	–	–	–	2,500	grease and sawdust.	–	–	Found that several lumps of the wad left the gun, but that the bore was clean and sufficiently lubricated after 32 rounds at various elevations; large coin not used; small coin used by No. 4 from in out answered very well; flew out each round, but as it flew back fell inside the carriage, thereby doing no injury, and was easily picked up again. Tangent scale dropped each round; concussion loosened the screw. Breechings were used, and being too short, could not satisfactorily determine the recoil. Gun was left after 32 rounds without being sponged; vent-piece out, and both ends clear so as to admit a free current of air. First and second rounds horizontal; found buffers came off pins, and remained stuck to the recoil carriage, and remained there during the day. Small coin (used as above) flew back, gunboat rolling about 4°. Third round, 10° elevation; gun recoiled on slide about two feet, rear chock compresser slackening each round; depression chock back. Fourth round, 18° 30′ elevation gun resting on bed; stool and depression chock back; a sharp recoil, but nothing very severe. Fifth round, 1° elevation, coin, bed, and stool square, depression chock back. Sixth round, 3° elevation, large coin on bed without stool, coin flew to the rear violently. Seventh round, 5° 47′ elevation, rolling from 3° to 5° small coin from in out; depression chock back. Eighth, ninth, and tenth rounds, ricochet to the right, tangent sight falling each round, small coin dropping on slide; also up to 22 rounds elevation varying from 5° 40′ to 6° 10′. 23d, 24th, 25th, extreme elevation in quick time, gun rather warm; afterchain guy of boat's davit about two feet above the muzzle was found to be covered with grease. From 26th to 32d, practice good; no trouble found in loading the gun; wad once or twice capsized, owing to No. 1 not being sufficiently careful in shoving it far enough home.	- ditto.

RETURN from the "Cambridge" of Trials of Rifled Ordnance since 1 January 1859, &c.—*continued.*

DATE.	Rounds. Shot.	Rounds. Shell.	Fuzes. T.	Fuzes. C.	Fuzes. P.	Distance of Target.	Nature of Wads, &c.	Force of Wind.	State of Weather.	REMARKS.	Name and Rank of Officer Superintending.
						Yards.					
40-Pounder Armstrong—*continued.*											
1 Oct. 1860	58	–	–	–	–	– –	– –	2	B. C.	Bore perfectly clean; one or two small spots of rust close to the muzzle; went on firing without cleaning the bore, and without sponging; no breeching used; recoil depended greatly on No. 4 bouncing the compressor well taut, and keeping a strain on the lanyard; the higher the elevation the greater the recoil on the slide; rear chock compressors slackened up each round; so hitched the side tackles. First round, with 19° elevation, carried away right side tackle; second round carried away the left side tackle. When using extreme elevation the gun requires to be elevated to enable it to be loaded. The first six rounds quick firing horizontal; large coin on side; tangent sight out; time 2 min. 35 sec.; coin caused delay by being so clumsy to handle; water smooth; ricochet about 1,000 to 1,500 yards, with average of three skips; first to second very long, and good direction; afterwards in any direction. 7th to 18th round, from 5° 10′ to 6° elevation; first three rounds gun recoiled up to step, and about four feet on slide, owing to No. 4 not keeping compressor bouced well up, and slide compressor was useless; practice very good, using depression chock and small coin. 19th to 24th round, gun on bed, depression chock in, elevation 8° 30′ quick firing, time 2 min. 8 sec. 25th to 52d rounds, 5° 20′ to 5° 40′ elevation; practice excellent. 53d to 58th, extreme elevation 19° 45′ (time of flight, 25″); gun recoiled heavily, but most severely on slide, carrying away both side tackles, which were hitched to assist rear chock compressors; the gun required elevating to be loaded; ceased firing; the bore clean, and left without sponging; found a crust in hollow of grooves about the thickness of a sheet of thin paper.	J. P. Jones Parry, Lieutenant.
8 Oct. „	60	–	–	–	–	– –	Grease and sawdust.	5	B. C.	Examined bore, which was clean and free from rust; rifling crusted, as before noticed; top carriage pivoted to slide; commenced firing with 7° to 7° 50′ elevation; 6′ right deflection; fired 12 rounds with wads, 3 grease, and 1 sawdust; 11th shot stripped, but hit the rock, lead striking the shore at right angles; examined the bore, and found it more foul than on any previous firing, especially in chamber and extreme of rifling; sponged the gun out, but was obliged to take the breech screw out to scrape the chamber clean; the crust seemed to be a mixture of sawdust, powder, and tallow, hard and sticky; continued the firing with wads, two parts grease and one part sawdust; 12th to 18th round, six rounds quick firing, 8° 30′ elevation, time 2 min. 45 sec. 19th round, extreme elevation 19° 45′; split pivot chock of slide, and started slide pivot bolt in deck, gun recoiling very little on top carriage; took top carriage off pivot, and shackled breeching from rear chock loops, to breeching shackles on slide, and continued firing. 20th to 60th round, from 5° to 6° elevation, practice not so good as on former occasions; bore left unsponged, dry and clean. There being so few of the wads composed of three parts grease and one part sawdust rendered it impossible to make a fair comparison with the others, but the 12 taken note of appeared to leave the bore much more foul than when firing with wads two parts grease and one part sawdust.	
22 Oct. „	29	–	–	–	–	2,000 to 2,600	– –	6	C.	Fired 29 rounds at various ranges, using both pivots, deck pivot yielding each extreme round, rent in slide not appearing to increase; left upper carriage compressor slack, both with extreme elevation and 4° elevation; gun did not recoil with any violence at extreme elevation, but at 4° the difference was apparent. Fired six rounds with depression chock taken away, so as to allow the gun to lay on the base or iron bar; breech lever just working clear in groove cut for that purpose; elevation about 24°; it was difficult to take time of flight, owing to the quick rolling, and being almost impossible to see the shot drop; using 14′ to 20′ right deflection; gun left without sponging, last time sponged being after 12th	Captain Jerningham, and Lieutenant J. P. Jones Parry.

											round, making in all 77 rounds of two grease and one sawdust; bore clean, except the chamber and extremes, which became coated, as noted before, with a thick skin, composed apparently of flannel, powder, grease and sawdust. From the 5th to the 15th round, 19° 45′ elevation, deck pivot working, slide pivot showed no further sign of weakness. From 16th to 22d round, with extreme elevation, depression chock removed; slide secured so as to throw as much of the recoil as possible on top pivot; compressors left slack; top carriage did not recoil further than usual up the incline, and top pivot remained firm. 23d to 26th rounds fired at various distances. 27th to 29th, with 13° elevation, a damp, wet day, the spray and sea flying over the gun; bore after 29 rounds appeared clean, chamber foul. This day's practice completed 179 rounds, at various elevations, the gun having been sponged once, and that after the 102d round, the bore having been exposed to the atmosphere for 14 days, thus proving grease wads very efficient. Up to 10° elevation the recoil acts chiefly on top carriage, after that on pivot; no part of carriage showed any signs of weakness; elevating gear very perfect; if coins were made of some reasonable form, and will probably be always required to work from in out. Owing to the very small hold that the handspikes have on the breech, and the brass patch under the breech, in its present form, seems next to useless. The shackles placed in top carriage to reeve a breeching, if required, are not sufficiently strong for that purpose, both being started the first few rounds. On one occasion the lead became disengaged, flying off some 400 yards at right angles, the shot keeping a true direction, but making a peculiar noise in the air.	
170 rounds were fired between 29th October 1860 and 31st January 1861, from the 40-pounder Armstrong, but no record appears on this ship's books of the particulars.												
R R	14 Jan.	1861	7	3	–	–	–	1,000 to 2,100	lubricating	3 to 4	–	The practice was exceedingly good, shell bursting with great precision, and without any shot stripping; the wads were efficient as a substitute for sponging the gun; there was a considerable escape of gas through the vent piece, which caused the breech screw to work somewhat hard, the particles of powder clogging the thread of the screw; recoil up incline averaging from 1 ft. 11 in. to 2 feet.	S. G. Price, Lieutenant.
	21 Jan.	„	8	5	–	–	5	1,000 to 1,300	- -	–	–	Accuracy of the practice varied very much in consequence of considerable motion of the gunboat; a heavy ground swell running from the S.W. At the expiration of sixth round found great difficulty in screwing up the breech; examined it and found, that from the escape of gas, as mentioned on January 14, the threads were completely clogged; had it thoroughly cleaned and oiled, and proceeded with the practice, but found it again necessary to repeat the operation after the 12th round; the recoil up the incline averaged as before, from 1 ft. 11 in. to 2 ft; the percussion shell fired at the sixth round burst immediately on leaving the gun, and several others on striking the water at different distances.	Ditto.
	4 Feb.	„	12	9	–	–	–	1,900 to 2,600	- -	5 to 7	C.	Shell very uncertain; the lead stripped off, the 12th shot going, as usual, with great velocity and high trajectory to the left; deflection occasionally as much as 18′.	Hy. Nicholson, Lieutenant.
	9 Feb.	„	8	–	–	–	–	1,900 to 2,300	greased.				
	25 Feb.	„	10	14	–	–	14	600 to 2,800	- ditto -	–	–	The last 12 rounds, breech screw became partly clogged from the escape of gas.	
	26 Feb.	„	20	–	–	–	–	1,500 to 2,200	- -	–	–	Breech screw clogged from the escape of gas.	
	4 March	„	20	7	–	–	7	400 to 2,000	- ditto -	–	–	Breech screw clogged from the escape of gas. The last three rounds, the fighting bolt in slide started.	
	6 March	„	28	–	–	–	–	2,000 to 2,700	- ditto -	5	C.	After 18th round, fighting bolt in slide broke in two; escape of gas great; breech screw clogged. Fire caused by escape of gas caught mat placed on top of gun. Obliged to cease firing this gun, no facing tools having yet been received.	Ditto.
	11 March	„	15	–	–	–	–	1,800 to 2,700	lubricating	7	Q.	Gun recoiled up the incline, varying from 1 ft. 8 ins. to 2 ft. 6 ins., gunboat at times rolling heavily; deflection from 10′ to 20′ right.	Ditto.

RETURN from the "Cambridge" of Trials of Rifled Ordnance since 1 January 1858, &c.—*continued.*

DATE.	Rounds. Shot.	Rounds. Shell.	Fuzes. T.	Fuzes. C.	Fuzes. P.	Distance of Target.	Nature of Wads, &c.	Force of Wind.	State of Weather.	REMARKS.	Name and Rank of Officer Superintending.
						Yards.					
40-Pounder Armstrong—*continued.*											
12 March 1861	29	–	–	–	–	2,000 to 3,000	lubricating	6 to 8	Q. P.	The carriage was not pivoted to slide, but allowed to recoil in; the recoil on slid varying from 13 ins. to 3 ft., and up incline, from 18 ins. to 2 ft. Ferguson's compressore being set up, in no case did she tauten breeching.	Hy. Nicholson, Lieutenant.
18 March ,,	32	2	–	–	2	1,300 to 2,000	- ditto -	4	Q. P.	The screw of compressor, after eight rounds, became stiff, which made it difficult to keep the gun up after recoil.	—
25 March ,,	24	1	–	–	1	1,600 to 2,600	- ditto -	1	B. C.	Deflection varying from 0′ to 10′ left - - - - - - - - - - - -	Hy. Nicholson, Lieutenant.
2 April ,,	31	–	–	–	–	1,450 to 2,700	- ditto -	2	B. C.	The fighting bolt in deck started after the 13th round. One of the four copper bolts broke off (defective material).	- ditto.
8 April ,,	11	2	–	–	2	900 to 2,100	- ditto -	3	B. C.	Deflection varying from 4′ to 10′ left - - - - - - - - - - - -	Wm. Dawson, Lieutenant.
22 April ,,	9	9	9	–	–	1,000 to 1,500	- ditto -	3	B. C.	Deflection from 0′ to 4′ right. After the fourth round, breech screw became considerably clogged from escape of gas, which made it difficult to work.	S. G. Price, Lieutenant.
29 April ,,	16	8	8	–	–	500 to 2,000	- ditto -	2	B. C.	Deflection from 0′ to 6′ left; recoil varying from 10 to 20 in. On April 24th, refaced for the first time after 165 rounds.	- Ditto.
6 May ,,	15	1	Pillar fuze -			1,350 to 2,400	- ditto -	2	B. C.	Deflection from 4′ to 12′ left; recoil up, from 10 to 21 in.; fired shell into cliff with pillar fuze without bursting charge.	- Ditto.
12 May ,,	14	5	5	–	–	1,000 to 1,500	lubricating with dry sponge.	–	–	Deflection from 0′ to 4′ right; recoil up incline from 1 ft. 4 in. to 1 ft. 10 in. Ninth round, shell burst shortly after leaving the gun. Eighteenth round, burst on leaving the gun. Last round, the shell did not burst.	- Ditto.
16 May ,,	18	–	–	–	–	800 to 2,000	lubricating	1	B. C.	Found breech screw difficult to work after eighth round - - - - - - -	Mr. Cockram, gunner, 3d class.
10 June ,,	27	–	–	–	–	1,900 to 2,200	- ditto -	3	B. C.	The bed of this carriage was fitted with elevating screw attached to the bed and worked through crossbar in ratchet. First round, compressor did not act; second round, elevating screw canted, arm going into bed; third round, broke arm of elevating screw; used small coin after this. The practice, this day, proved a mean range of 94·6 yards over, and 30 yards short, whereas the mean range of the 68-pounder, 95 cwt., was 26 yards over and 12·6 yards short.	S. G. Price, Lieutenant.
13 June ,,	50	–	–	–	–	2,100	- ditto -	3	B. C.	After 29 rounds breech lever became hard to work; took it off and cleaned it. Thirty-fifth round started outer copper bolts in lower fighting bolt, and broke after outer one off. Small coin used, which flew out frequently, gun and vent piece being hot. The practice, this day, proved this gun to have 15 hits and a mean range of yards over 24, and short 24. The 68-pounder, 95 cwt., had 19 hits, mean range of yards over 20, under 18.	P. Fitzgerald, Lieutenant.
17 June ,,	11	5	–	–	5	2,200	- ditto -	4	B. C.	Everything at this carriage appeared to answer very well; worked starboard broadside.	
9 Sept. ,,	21	–	–	–	–	1,100 to 2,300	- ditto -	2	B.	Experimental firing to try the efficiency of the gun mounted as a broadside gun on a rear-chock carriage; the trial was very satisfactory. After firing the 16th round, the vent-piece was found to be severely fractured in the centre, and, in consequence, unfit for use. In training, the elevating screw runs down very much. During the practice, much time was lost in loading in consequence of the lubricating wads being too small, falling down as soon as put in.	

16 Sept.	„	10	7	7	–	–	1,000 to 2,400	- ditto -	3 to 5	C.	Recoil much more violent than on last occasion of firing, on account of breeching being shortened up; the same delay as before with lubricating wads, otherwise the gun acted very well in carriage.	J. P. Jones Parry, Lieutenant.
19 Sept.	„	4	–	–	–	–	1,800 to 2,200	- ditto -	2	B.	Rear chock carriage with breeching shortened to allow of 5½ feet recoil; the gun came in taut each round; water smooth. Two rounds were fired with breeching let out; gun recoiled about 7½ feet without tautening the breeching.	
2 Oct.	„	10	1	1	–	–	2,200	- ditto -	1	B.	First round, breeching shortened up to allow muzzle to clear fighting bolt; recoil moderately sharp. Second and third rounds, breeching unrove when the gun recoiled about eight or nine feet. Remaining rounds, breechings secured as first round, with same result.	J. P. Jones Parry, Lieutenant.
7 Oct.	„	14	–	–	–	–	2,300	- ditto -	2	.	Recoil not so sharp as on previous occasions. Gunboat pretty steady. Thirteenth round, shot stripped, pieces falling about 30 yards from the ship.	- Ditto.
14 Oct.	„	32	–	–	–	–	2,200 to 2,300	- ditto -	1	B.	A heavy swell outside, which caused the gunboat to roll considerably, and, at times, made the recoil sharp, otherwise the gun acted very well in every respect; breeching, ordinary recoiling length. Breech screw worked stiff after 30th round. After the 32d round, breech screw taken out, the end cleaned, and also the two inner threads of the female screw, after which it worked easy.	- Ditto.
28 Oct.	„	28	–	–	–	–	1,700 to 2,000	- ditto -	2 to 4	B. C.	The same complaint with lubricating wads as on previous occasions - - - - - -	S. G. Price, Lieutenant.
4 Nov.	„	5	6	–	–	–	1,550 to 1,750	- ditto -	2 to 4	C.	The same complaint with lubricating wads as on previous occasions - - - - - -	- Ditto.
5 Feb.	1862	21	6	6	–	–	2,000 to 3,000	- ditto -	2	B. C.	The gun was worked without a fighting bolt in fore chock of slide, an inconvenient arrangement, because the gun had to be run out every round, and there was considerable difficulty in properly attending the compressors.	Hy. Nicholson, Lieutenant.
4 March	„	17	8	8	–	–	1,750 to 1,650	- ditto -	2	B. C.	Seventh round, shot stripped - - - - - - - - - - - - - - -	Mr. W. Grigg, gunner, 2d class.
14 April	„	15	13	–	–	–	600 to 1,950	- ditto -	2	B. C.	Fifth and seventh, shell did not burst. During the practice from this gun, the wrought iron of vent piece immediately under the copper ring was gradually wearing away, and after the 17th round the escape of gas was proved to be considerable through the above-mentioned aperture. A new vent piece was substituted. At the conclusion of the following 11 rounds, the new vent piece was found to be worn away, much the same as its predecessor, which rendered it almost unfit for service. The 28th round the shell stripped.	S. G. Price, Lieutenant.

R R 2

19 May	„	3	1	1	–	–	800 to 1,200	- ditto.				
2 June	„	16	13	13	–	–	1,500 to 2,300	- ditto.				
16 June	„	16	18	18	–	–	1,100 to 1,800	- ditto.				
23 June	„	37	–	–	–	–	900 to 2,400	- ditto.				
30 June	„	15	14	14	–	–	1,100 to 1,900	- ditto -	–	–	Second shell stripped.	—
17 July	„	5	6	6	–	–	1,600 to 1,800	- ditto -	–	–	Tangent sight broken.	—
21 July	„	28	–	–	–	–	1,100 to 1,900	- ditto.				
4 August	„	25	–	–	–	–	1,100 to 1,900	- ditto.				
25 August	„	9	10	10	–	–	1,400 to 2,400	- ditto.				
1 Sept.	„	16	10	10	–	–	800 to 1,700	- ditto.				
8 Sept.	„	39	–	–	–	–	1,500 to 1,900	- ditto -	–	–	Vent-piece unfit for use.	—
16 Sept.	„	26	–	–	–	–	900 to 1,900	- ditto.				
22 Sept.	„	15	13	13	–	–	1,600 to 2,100	- ditto -	–	–	Sixth, seventh, and eleventh, shell did not burst.	—
6 Oct.	„	18	16	16	–	1	800 to 2,100	- ditto -	3	B. C.	Third and eleventh, shell did not burst. The iron of the vent-piece, under the copper ring, considerably indented, which, combined with a thick deposit forming on the inner face of the vent-piece and lower part of chamber, caused an escape of gas through the slot. The 15th shot stripped.	C. S. Stanley, Lieutenant.
13 Oct.	„	9	7	7	–	–	1,700 to 2,200	- ditto -	6 to 7	D. R.	Fourth shell did not burst - - - - - - - - - - - - - - -	A. G. Wooton, Lieutenant.
12 Nov.	„	14	16	16	–	–	1,100 to 2,100	- ditto -	–	B.	Fifth shell did not burst. Seventh and 16th burst half distance. During the practice, the breech lever worked so stiffly that it had to be oiled.	S. G. Price, Lieutenant.
24 Nov.	„	23	12	12	–	–	1,500 to 2,200	- ditto -	5	B.	Second, fourth, sixth and eleventh, shell did not burst - - - - - - - - -	- Ditto.
8 Dec.	„	15	15	15	–	–	800 to 2,100	- ditto -	2	B. C.	Second, fifth, ninth and eleventh, shell did not burst.	

RETURN from the "Cambridge" of Trials of Rifled Ordnance since 1 January 1858, &c.—*continued.*

DATE.	Rounds. Shot.	Rounds. Shell.	Fuzes. T.	Fuzes. C.	Fuzes. P.	Distance of Target.	Nature of Wads, &c.	Force of Wind.	State of Weather.	REMARKS.	Name and Rank of Officer Superintending.
						Yards.					
40-Pounder Armstrong—*continued.*											
5 Jan. 1863 -	40	1	1	–	–	1,800 to 2,000	sponge	3	Q.	Thirty-seventh round carried away thumb-screw of tangent sight.	
19 Jan. „ -	–	29	29	–	–	1,200 to 1,700	11 with lubricating, 18 sponge.	6	Q.	Sixteenth round carried away left compressor - - - - - - - - - -	C. S. Stanley, Lieutenant.
20-Pounder Armstrong, 12½ Cwt.											
Fired from a fixed battery on shore at Bovisand.											
2 April 1861 -	9	2	–	–	–	2,400	sponge -	2	B. C.	Ascertained the elevation for 2,400 yards to be 8° 10′. Deflection used 10′ left. The shot requires to be set home by 3 and 4.	Hy. Nicholson, Lieutenant.
8 April „ -	6	–	–	–	–	2,400	sponge -	3	B. C.	The shot fell short from 20 to 100 yards, although using the same elevation as above - -	W. Dawson, Lieutenant.
29 „ „ -	8	8	–	–	–	1,000	sponge -	2	B. C.	The first shot, with 3° 21′ elevation, was 20 yards short; the second, with eye close up to sight, 30 yards short; fourth round, eye close to sight with 3° 30′ was 10 yards over; deflection, 10′ right.	S. G. Price, Lieutenant.
6 May „ -	28	–	–	–	–	2,400	lubricating	2	B. C.	Object large, it being low water up to the 18th round; eye close up to sight; the remainder, object was small.	Ditto.
13 May „ -	54	7	2	5	–	2,400	- -	3	B. C.	Sixteen rounds fired with eye close to sight; 45 rounds at extent of trigger line - - -	Ditto.
21 May „ -	55	–	–	–	–	2,400	sponge and wad.	2	B. C.	Fired at the extent of trigger line; third round, vent-piece, not being screwed in, flew out at firing and went over Bovisand hill.	Ditto.
3 Dec. „ -	21	–	–	–	–	1,500 to 2,300	lubricating	3	B. C.		
12 April 1862 -	15	–	–	–	–	2,300	lubricating	2	B. C.	Deflection from 0′ to 10′ right.	
Fired from the "Redwing" Gunboat under weigh.											
9 Sept. 1861 -	11	–	–	–	–	1,100 to 2,400	lubricating	2	B.	The charge for this gun appears too great, causing a violent recoil, for which the carriage is badly adapted, being too short; the gun tilts on its muzzle.	Mr. T. Mankey, Gunner, 1st Class.
16 Sept. „ -	12	–	–	–	–	1,000 to 2,400	lubricating	2 to 3	B. C.	The recoil for the first five rounds was very violent. After the fifth round the breeching was shifted from the side of the brackets to the rear and underneath part of the brackets, the bights seized to the side loops. The first round fired with the breeching this way, the gun came in and canted with its muzzle up at an angle of about 90°; the next round the breeching was shifted from the underneath to the upper part of the brackets; the second round this way the gun came in and formed a quarter circle with its muzzle forward; two breechings were then seized together to give a longer recoil, when the gun recoiled very violently for two or three rounds, and the 11th round canted with the muzzle on the deck.	J. P. Jones Parry, Lieutenant.
Firing from the Launch under weigh.											
22 Jan. „ -	16	10	–	–	–	700 to 2,500	- -	–	–	Mounted on a common boat's carriage and slide, with a 12-pounder 5-inch breeching rose round the stem. Boat rolling considerably. Firing very good. Gun recoiling each round to a taut breeching about 7 feet 6 inches on slide. Missed fire twice. Recoil did not appear more violent than that of a 24-pounder howitzer. Boat knocking about very much. Pulled under lee of breakwater, and fitted carriage on Sir William Armstrong's principle of non-recoil with indian rubber buffers and rods. Buffer compressed 12 inches, with a heavy recoil in and out; bent bar about one inch out of horizontal; carried away cross	Ditto.

	28 Jan.	„	17	–	–	–	–	– –	– –	–	–	piece that holds pivot bolt, bending the bolt; compressor was slack; used 11 rear buffers and three front; ceased firing owing to rear bearing of rod cutting into the slide. The jump of the gun was very violent. Heavy swell. Boat very lively. Groove in slot strengthened with iron plates. Compressor taut. Recoil 9¾ inches. Had to ease compressor and man side tackles to get gun out. Recoil, not very violent. Had to use primers the remainder of the day owing to continuous misfires; not to be accounted for unless owing to damp atmosphere. Fourth round, took off three rear washers, shortened breeching up so as to take strain when buffers were about half compressed, allowing for 14 inches recoil. 6th round, another rear-washer was taken off; compressor slack. Jumped more and not sufficient strength to rebound out; breeching as before. 10th round, put on another rear buffer; compressor slack. Hammer being left on gun without being removed disabled friction crutch by falling on it each round. Used lock and X headed tubes. 17th round, observed slide split amidships, owing to jump on downward strain on rod. The rod was bent upwards about two inches out of horizontal; no other part of the gun, carriage, or boat showed sign of weakness. Very little alteration suggested; the principle approved of.	- Ditto.

DATE.	Rounds.		Fuzes.			Distance of Target.	Nature of Wads, &c.	Force of Wind.	State of Weather.	REMARKS.	Name and Rank of Officer Superintending.
	S ot.	Shell.	T.	C.	P.						
						Yards.					
110-Pounder Armstrong—*continued.*											
9 Feb. 1863	49	–	–	–	–	From point blank to extreme elevation.	lubricating	2	C.	The firing from this gun from 9 February 1863 to 20 February 1863, was in obedience to an order from the Commander in Chief, dated 8 July 1862; to fire 300 rounds to test a new garrison sliding carriage, fitted with cast-iron flanges instead of wrought-iron straps; the carriage was received January 1863. Time firing first 20 rounds, gun horizontal, ship on an even keel; 1st round commenced at 10 hrs. 10 min. 40 sec.; the 10th round at 10 hrs. 29 min.; 20th round, 10 hrs. 47 min. 30 sec.; total time firing 20 rounds, 36 min. 50 sec. The second 20 rounds, elevating screw close down, ship on an even keel; the 1st round commenced at 11 hrs. 15 min.; 10th round, 11 hrs. 27 min.; 20th round, 11 hrs. 46 min. 30 sec.; ceased firing 30 minutes, range being foul; total time firing these 20 rounds, 31 min. The last nine rounds were with extreme elevation, bed and screw out, commenced at 1 hr. 32 min.; 9th round, 1 hr. 53 min. 30 sec.: total time firing nine rounds, 21 min. 30 sec. 9th round, time of flight, 21 sec.; after the firing was over ran the gun out 31 times, with 40 men at the side tackles, but found concussion to have no effect on roller plates; the plates throughout the trial showed no weakness.	S. G. Price, Lieutenant.
10 Feb. ,,	63	–	–	–	–	From extreme depression to extreme elevation.	- ditto -	2 to 3	C.	This day commenced firing at 10 hrs. 2 min. 23 sec. at extreme depression, rolling 4°; First round, metal plate of elevating screw came out of its seat. 4th round, vent piece split; 45 seconds lost in shifting it. 6th round, slide ragged with right compressor. 10th round, list of ship towards the object, 5°. 11th round, carried away left side tackle through not being clear; lost 1 minute 15 seconds in shifting it. 12th round, missed fire; bad tube. 13th round, shot jammed through inner face of breech screw being burred; lost two minutes; took screw out, and filed burr down; tried the difference of diameter of two shots, found it to be ·06. 15th round, vent piece jammed in slot; found it was split; lost 1 minute and 30 seconds. 17th round, plate of elevating screw came out of its seat, which, on recoil, caused head of elevating screw to go into slot, which continued to do so up to the 20th round. With extreme elevation in firing the 20 rounds, the first 10 rounds was in 22 min. 20 sec., and the second 10 rounds in 24 min. 6 sec.; total 46 min. 26 sec. The second 20 rounds—the 1st round fired at 12 hrs. 3 min. extreme elevation; time of flight, 22 sec.; the time firing first 10 rounds, 24 min. 5 sec. Ditto, the second, 25 min. 15 sec.; total, 49 min. 20 sec. Had to elevate every round to unscrew breech screw, and allow five and six to load; heel of ship 3° towards the object. The third 20 rounds—the first round fired at 12 hrs. 58 min. 18 sec., elevation 4°, heel of ship from 2½° to 5° towards the object; time occupied firing the first 10 rounds, 20 min. 58 sec. Ditto, the last, 18 min. 21 sec.; total, 39 min. 41 sec. The 13th round, the chain of key of bed carried away; tangent sight slipping down every round. 15th round, left deflection screw useless through concussion; right compressor ragging slide slightly. 20th round misfired, through head of tube breaking off; the last three rounds, heel of ship 2°; elevating screw close down; depression chock back; left lever bent; time, 3 min. 14 sec.	- Ditto.
11 Feb. ,,	38	14	14	–	–	1,900 to extreme elevation.	- ditto -	4	B. C.	The first 20 rounds, extreme elevation; time of flight, 23 sec.; first round fired at 9 hrs. 57 min.; the 20th round, 10 hrs. 54 min.; lost eight minutes in shortening breeching, and six minutes in ramming shot home, through tin cup being underneath; time firing 20 rounds, 43 min.; the second 18 rounds fired at 10 hrs. 56 min., extreme elevation; time firing 18 rounds, 32 min.; fired 14 rounds of shell, firing at target, elevation 5° 5′; first eight, shell burst; six did not; one shell stripped.	- Ditto.

12 Feb.	„	50	–	–	–	–	700 to 1,700	lubricating	2	B. C.	The first 10 rounds quick firing, extreme depression. 9th round, handle of breech lever broke off close to knob, by concussion; time occupied firing these rounds, 30 min. After which each man fired two rounds of independent firing, changing rounds after the second shot; time occupied firing 38 rounds in this way, 1 hr. 29 min. At the 9th round of this firing the other handle of breech lever broke off close to knob.	Ditto.
13 Feb.	„	20	10	10	–	–	1,300 to 1,900	ditto	3	B. C.	The 4th, 6th, 8th, and 9th rounds of shell did not explode	Ditto.
16 Feb.	„	18	–	–	–	–	3,100 to 3,300	ditto	4	B. C.	First round fired with extreme elevation; everything worked well; each man fired two rounds and then changed rounds.	Ditto.
17 Feb.	„	10	23	23	–	–	700 to 2,300	ditto	2, 3	B. C.	This day's firing, each man fired two rounds and then changed rounds; time occupied firing 33 rounds in this way was 1 hr. 44 min. 39 sec. The 1st, 3d, 4th, 7th, 11th, 13th, 14th, 16th, and 21st shell did not explode; the 7th and 10th shot stripped; the 30th round, the crutch on vent piece broke off. Everything else worked well.	Ditto.
18 Feb.	„	–	5	–	–	–	Extreme depression.	ditto	0	B. C.	Extreme depression; time of firing five rounds, 14 min. 12 sec.; found vent piece jammed each round, requiring a handspike to free it, which caused a delay of two minutes, to be subtracted from the above time. Found extreme depression to be 9°; extreme elevation, with screw in bed, 7° 30′. Ditto, with screw in axletree, 11° 30′. Fighting bolt started.	Ditto.
20 Feb.	„	10	–	–	–	–	Extreme elevation.	ditto	–	–	Extreme elevation; time firing the last seven rounds, 11 min. 15 sec.; the gunboat was heeled over by weights to about 5°, away from the firing side, and guns fired at the top of the weather roll; time of flight, about 30 seconds.	Hy. Nicholson, Lieutenant.
		9-Pounder Armstrong Gun.										
		Fired from a fixed battery on shore at Bovisand.										
14 April	„	25	–	–	–	–	2,300	wad in charge.	3	B. C.		

Her Majesty's Ship, "Cambridge,"
Devonport, March 11, 1863.

L. G. Heath, Captain.

REPORTS and Letters relating to Experimental Firing.

—No. 1.—

H. M. S. Cambridge, Devonport,
Sir, 13 July 1860.

I have the honour to submit to you the accompanying notes and remarks, relative to the Armstrong 12-pounder, and remain your obedient servant,

(signed) *A. W. Jerningham,*
Captain.

To Captain R. S. Hewlett, C.B.,
H. M. S. Excellent.

On the 29th May, there were 25 shell fired from the "Redwing," at 2,400 yards range, from the Armstrong 12-pounder, according to an account taken by Mr. Williams, gunner (they were fitted with both fuzes); four did not burst, and one burst half-way. The time fuzes were set at full length, and although they were all set alike, only four appear to have bursted in the same place. The metal collars of the time fuzes were so corroded, that there was difficulty in moving them; so hard were they, that they required hammering round.

6th June. The same complaint is made; eight out of 30 not bursting, and few bursting alike. On the 11th and 18th June, the same remarks hold good; the difficulty of turning the collars is particularly noticed.

2d July. Twenty shells fitted with concussion fuzes, were fired at the Shag Rock, but there was a great difference of opinion as to how many burst.

The key and wedge of the trunnion sight flies out on firing; although you may hammer them in, in three or four rounds they are out again.

The tangent sights are frequently getting adrift; the heads of the screws come off and on.

On the 6th of June, the elevation vernier got a blow, which slightly bent it, and we could not get it to work.

The screw wrench does not answer to screw the fuzes in the shell; it will not hold. The spring of the tangent box gets bent, and you cannot enter the sight.

The elevating screw, the threads of which finish off to too fine a point, consequently are easily damaged. Two of the copper studs on the vent piece have broken off.

The field carriage does not give 6° of elevation to the gun, the tangent scale being marked to 10°. This is very inconvenient when firing down an incline; the boat carriage gives 8°; marks on centre base sight too small, and should not be on back on sight.

Vernier unnecessary for ordinary sea purposes.

I am of opinion that the traversing screw will be very useful in pivot guns, and on all guns on slide carriages.

(signed) *A. W. Jerningham,*
Captain.

—No. 2.—

40-Pounder Armstrong Gun.

Sir, London, 16 November 1860.

I have the honour to enclose for the information of my Lords Commissioners of the Admiralty, a report on the experiments of the 40-pounder Armstrong gun, conducted by me in the gun-boat "Redwing," at Plymouth.

2. One hundred and ninety-five (195) rounds with shot were fired from 0° to 24° of elevation, during which, no part of the gun, breech, screw, or vent-piece, showed any signs of weakness. There was no escape of gas, nor was there any check in the facilities of loading, during the 195 rounds, which occupied four days. A week elapsed between each day.

3. The gun remained, after each practice, exposed to the atmosphere, the weather being wet, boisterous, and all the time damp. The gun was not sponged for the first 101 rounds, when the bore required cleaning. Subsequent practice showed a similar result. Lubricating wads were used, which were perfectly successful.

4. The gun is well balanced in the trunnions, and remains steady, without jumping, when fired at the several elevations. No opportunity offered of trying depression.

5. Some improvement in the sights for sea service is suggested herein. That used on the 40-pounder, fired from the shore, answered well; and the practice was most accurate.

6. The carriage of the gun is strong and serviceable. The very severe, indeed I may say violent, test, to which it was subjected in the experiments, is sufficient proof of its power of endurance. Thirty-four rounds were fired with extreme elevation, the last fire at 24° with both flaps down, the gun being elevated 2° above the incline of the carriage. The only damage done, was the drawing of the pivots from the deck, and from the long slide, and the breaking of the gauge glass in the engine room. The object of this trial was to ascertain the endurance of the gun and breech screw, the strength of the carriage slides, pivots, and deck, under extreme circumstances, which, except for experiment, would not be likely to occur.

7. The present mode of fitting the breeching requires alteration, when it would relieve the pivot in the deck, as well as the rear compressor.

8. There is but one range, viz., 2,423 yards, for practice from the shore to a fixed object, which was the Shagstone Rock, showing a surface of 15 feet square in the sea. At this range, the practice was unerring.

9. The practice afloat was not equal to that on shore, nor superior to the 68-pounder in the gunboat. This may be attributed to the constant changing of position, and motion of the vessel, to the remediable defects in the elevating gear, and the sights alluded to in paras. 8 and 19 of the enclosed report, as well as to the absence of the table of ranges, or any data connected with the 40-pounder gun.

10. No experiments in firing from the "Cambridge" could be tried, the range of St. John's Lake being too confined.

I have, &c.
(signed) *A. W. Jerningham,*
(Captain, H. M. S.
"Cambridge.")

Vice Admiral
Sir Houston Stewart, K.C.B.,
Commander in Chief,
Plymouth.

Report of the Experiments of the 40-pounder Armstrong gun, No. 90.

No. of rounds, from 0° to 10° of elevation	133
Fired from 10° to 20° of elevation - -	34
Fired from extreme elevation - - -	28
	195

The Gun.

1. No part of the gun, breech, screw, or vent-piece showed any sign of weakness. There was no escape of gas apparent, nor was there any check during the 195 rounds fired, in the facilities of loading.

The fouling of the Bore of the Gun.

2. The practice commenced on the 24th September 1860; 32 rounds were fired without sponging, using the lubricating wads. The gun was then left with muzzle, stopper, and vent-piece out, the breech screw remaining in the gun; the bore being thus exposed to the action of the weather for one week, during which time it was rainy and boisterous.

3. On Monday, 1st October, 58 rounds were fired, the bore having been previously found clean and free from rust, with the exception of two small spots near the muzzle, which disappeared after the first round. On examining the gun after this day's practice, a hard crust was found in the grooves of the rifling, but it did not appear to affect the accuracy of the firing. The gun was again left for a week to the action of the weather, which still continued damp.

4. Monday 8th October, recommenced firing after the 11th round on this day, making 101 rounds (firing altogether from the commencement without sponging), the leaden jacket stripped off; the shot, flying at right angles to, and to the left of the range, fell 300 yards from the gunboat.

It being desirable to ascertain whether this was caused by the foulness of the bore, or by defect in the manufacture of the shot, a 12th shot was fired, and although it did not strip, it was so irregular in its flight, leaving the gun with such a whistling noise, that it became evident that the state of the bore rendered further practice uncertain; the gun was therefore sponged out.

5. On Monday, 22d October, the gun having been carefully cleaned and sponged out, the practice was recommenced; 29 rounds were fired without sponging, after which the rifling was clear. The chamber was slightly coated with a sticky paste, consisting of powder, grease, and sawdust. On a subsequent occasion, a week having expired, and the gun having been left exposed to the weather as before, 64 rounds were fired, making 93 in all since the gun was last sponged. No irregularity was observed in the flight of the shot, nor did any appear to strip. On cleaning out the gun, it was depressed, and the deposit was allowed to run into a bag made of bunting. This was afterwards dried and carefully examined; it was found to contain a very few minute particles of lead, which were difficult to discover with the naked eye, whilst sawdust formed the principal portion of the deposit.

The Preponderance of the Gun.

6. The gun is well balanced on the trunions, and remains steady when fired at the several elevations.

Trunion Sights.

7. The shoulders are not sufficiently broad or solid; when the gunboat had much motion, the captain of the gun was apt to get the shoulder, instead of the centre of the sight, on with the object. It would be very desirable to have a longer radius with a tangent sight fitted on the top of the gun, somewhat similar to that in use on the Enfield rifle, and capable of being used at the extent of the trigger line.

The Tangent Sight.

8. The tangent sight, which is now hexagonal pattern, slips down after every round, except when raised for high elevations, when it bends slightly every round. This after 20 rounds occasioned a difficulty in moving the sight. It is also exposed to any injury from the right handspike. On one occasion, in the presence of the Lords of the Admiralty at Plymouth in September last, at the fifth round of these experiments, and the second before their Lordships, the small coin flew back, striking and bending the sight so as to render it unserviceable for the time. In working the gun mounted in a lower deck port on board the "Cambridge," when extreme trained to the right, the line of sight (owing to the sight being placed on the right of the gun) is interrupted by the side of the port; this occasions the loss of some training to the right. The sight being placed on the right of the gun also interferes when pointing with the trigger line, which being held in the right hand, crosses and interrupts the line of sight; to avoid which, the captain of the gun is led to fire with the left hand. This can be remedied by placing the sight on the left top of the breech of the gun as alluded to in paragraph No. 9.

Wads.

9. Two sorts of wads were supplied, the one consisting of two parts of grease to one of sawdust, the other three parts of grease to one of sawdust; they both appeared to answer the purpose for which they were intended, viz., avoiding the necessity of sponging; but those containing two parts of grease appear to preserve sufficiently the rifling from getting leaded, and the bore may be exposed for several days to the action of the damp atmosphere without injury.

The Breech Screw.

10. The breech screw seems to work easily and safely. It is, however, of importance that it should be firmly screwed up when the gun is in action. It seems to prevent completely the escape of gas.

App. No. 6.

The brass plate under the breech of the gun is intended to rest on the top of the elevating screw.

11. In its present form it is not applicable for coins, rendering the operation of elevating slow and unsteady, and causing the small coin to fly out when the gun is fired. This appears capable of easy remedy.

Carriages.

12. Two carriages were supplied, numbered respectively 70 and 79. They are similar in all respects, excepting the elevating gear; with the former (No. 70) mounted on the lower deck of the "Cambridge," which I call the ratchet carriage, the bed of which has an iron plate with projecting ends attached to its under side, is shifted from notch to notch in an iron frame. This and a small coin complete the elevating gear of the gun. It is, however, of importance, that these notches should be so placed in all the carriages on each deck, as to give a similar number of whole degrees in the elevation when shifting the bed. This is essential in laying guns on each deck to the same horizontal plane for broadside or concentrated fire. In the latter carriage, No. 79, mounted in the gunboat, a pivoted depression chock, a bedstool hinged under the bed, a large coin in two pieces, and a small coin constitute the elevating gear. Owing to the peculiar shape of the large coin, the gun does not rest firmly on it, thereby rendering the elevation tedious and uncertain.

13. The small coin was first used from rear to front, as well as sideways, it being bevelled off apparently for that purpose; but this caused the gun to slip down after resting on the coin, which was found to fly out with considerable violence. It was afterwards used from front to rear, which rendered the elevation less unsteady, but it still continued to fall out after every round.

The Bed.

14. When firing with elevation, the accuracy of laying the gun is seriously affected by the inner end of the bed canting up, it having considerable play, owing to the weight of the gun resting on that part of the bed which is to the rear of the ratchet.

When using lubricating wads, owing to the grease dropping through the chamber of the gun on the bed, sand had to be freely used to prevent the coin slipping when the gun rested upon it. The carriage, No. 70, has not been used in the gunboat. A gun was mounted upon it at Bovisand, from which five rounds were fired, as mentioned in paragraphs Nos. 8 and 12.

Recoil.

15. Firing the gun on the deck pivot only, the rear shock and Ferguson's compressors set up with elevation of 2°, the recoil on the slide was *nil.*

Up the incline plane of about three feet, elevation 5°, a recoil two feet up the incline plane, a slight recoil on the slide elevation 10°, two feet recoil on the slide, one foot up the incline plane.

Elevation 18°. A sharp recoil on the slide; a very slight recoil on the incline plane.

On a subsequent occasion when firing with 19½° elevation, the side tackles were hauled taut, and hitched to assist the rear chock compressor, the right tackle hook carried away the first round, the left tackle hook the second round.

The recoil when firing with depression has not been ascertained.

Pivots.

When firing the gun pivoted to the slide, and slide pivoted to the deck, the recoil up the incline plane has been greater, but the compressor appeared to have perfect control over it.

With 20° elevation at the first round, the fore chock of the slide (through which the pivot is bolted) was split, and the outer bolts of the pivot plate in the deck showed signs of starting.

A few more rounds were fired without materially increasing the damage to the slide and deck.

Subsequently, five rounds of quick firing, with 24° elevation, were fired; at the fifth round, the upper fighting bolt was broken, and torn out of the side; the bolt in the deck was torn up, the flap that goes over it being broken.

Breechings.

16. The breechings, which were single pendants of 4½-inch rope, one on each side of the gun carriage, started one of the lugs of the carriage on the first round of their being used. The use of them was consequently discontinued. Should a breeching be considered necessary for this nature of gun, it should be capable of being rendered on the bight, either on the gun and carriage, or on the ship's side.

Buffers.

17. The first time the gun was fired, three out of the five buffers stuck to the upper part of the carriage, straightening the pins which should have secured them to the fore chock.

On a subsequent occasion, when running the gun up the incline, which is mounted on board the "Cambridge," the pin remained straight, and tore through the buffer, which had adhered to the upper part of the carriage.

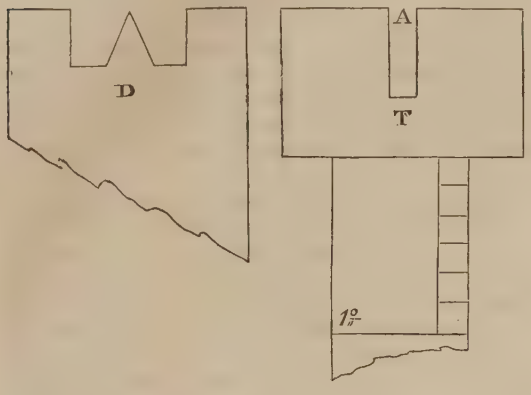
Compressors.

18. The upper compressor (Ferguson) acted perfectly, retaining the gun at the extent of the recoil up the incline. Those on the rear chock (common) partially slackened each round, but not more than the ordinary smooth-bored guns.

General Remarks.

19. On the first three days the weather was fine, the water smooth, the vessel rolling from four to five degrees, ranges varying from 1,700 to 2,500 yards, and constantly changing as the gunboat drifted in the tideway. The practice was very good, at an isolated rock called the Shagstone, about 20 feet square, having been frequently hit. On the fourth day there was a heavy tumbling sea; the practice from the Armstrong at 2,200 yards and under, on this day, was not superior to the 68-pounder. This I attribute to the defect in the elevating gear, and to the sight not being equal to the one fitted to the 68-pounder, which was a modification of Sir William Armstrong's pattern for land service, namely, the dispart, as marked

marked D, and the tangent sight marked T. By bringing the upper level of each on the object, the elevation is quickly and accurately attained. Again, by bringing the point of the dispart in the centre of the tangent sight at the point A, a very correct sight is obtained.



On the fifth day the weather was again moderate and the practice good.

Celerity of Fire.

20. Six rounds of quick firing were fired on the first occasion in 2 min. 25 sec.; on a second occasion 2 min. 8 sec.; on a third occasion 2 min. 35 sec. With a perfectly trained gun's crew, three rounds could easily be fired in one minute.

On firing with extreme elevations, the rammer, which is four feet in length, could not be worked without raising the gun each time.

The Practice.

21. The gun, No. 70, was landed and mounted at Bovisand; five rounds were fired at the Shagstone rock, at a range of 2,423 yards, the rock showing at that time of tide about 15 feet square. The first shot, to try the range, fell 20 yards short, the remaining four struck the rock in the centre every time. No table of ranges having been supplied, the gun was laid by experience with the 12-pounder in former practice from the same spot.

The practice afloat from the gunboat was not so successful, which I attribute to the remediable defect in the elevating gear, and the sights alluded to in paras. 8 and 19, and the absence of the table of ranges, or any data connected with the 40-pounder.

General effect of Recoil.

22. Up to 10° the recoil is very moderate, and chiefly up the incline. After this the recoil on the slide (or the strain on the pivot bolts) increases, the recoil up the incline decreases in proportion. As these guns must necessarily be required to be fired at high elevations from ships decks, it becomes evident that the pivot bolts, chock, and decks should be sufficiently strong to withstand the violence of the recoil.

Though it would be imprudent and rash to use this gun on the non-recoil principle, as I had expended all but five rounds of the 200 supplied for experiment, I reserved them for this purpose, the result of which was the drawing of both pivots. Had they not been weakened by previous practice, they would, I think, have withstood the five rounds without tearing away; the carriages and slide remained perfectly uninjured, with the exception of the chock of the long slide previously described in paragraph No. 15. App. No. 6.

(signed) *A. W. Jerningham*,
Captain,
H. M. S. "Cambridge."

Vice Admiral
Sir Houston Stewart, K.C.B.,
Commander-in-Chief,
Plymouth.

— No. 3. —

ARMSTRONG BOAT GUN.

H. M. S. "Cambridge,"
Hamoaze, 6 February 1861.

REPORT of a common boat's slide and carriage fitted with india-rubber buffer and compressor, mounting an Armstrong 25-pounder; weight, 12 cwt. 1 qr. 21 lbs.; charge, 2 lbs. 8 oz., from a 40-feet launch; fitted with a fighting chock, 3 ins. thick, supported by two knees on the after side; the pivot bolt 13 ins. long, and 1¾ ins. in diameter, keyed underneath the fighting chock.

Commenced practice on the 22d January 1861.

The number of rounds fired were, 34 with shot, nine with shell; total, 43 rounds.

The Slide.

1. The slide was an ordinary fir slide, 4 ins. thick, 9 ft. 3 ins. long, 1 ft. 8 ins. wide, supported in the rear by the usual rear chock. A longitudinal groove, half an inch deep, and one inch in width, the length 2 ft. 9 ins. from the rear of the slide, leaving 2⅛ ins. of thickness above, and 1½ ins. below.

Carriage.

2. The carriage was an ordinary boat's carriage, fitted with the service compressors, with the addition of india-rubber buffers.

Breeching.

3. The breeching used on the first occasion was 5-ins. rope rove round the stern, allowing the carriage to recoil 7 ft. 6 ins. from the fighting bolt.

Number of Rounds.

4. Twenty rounds were fired, 10 with shot and 10 with shell, boat rolling considerably, there being a heavy swell.

Recoil.

5. The recoil was felt to be more violent than with the 24-pounder howitzer. Having completed 20 rounds without apparently any injury being done to the boat, carriage, or breeching, the slide and carriage were fitted with a buffer, but, on finding the pivot bolt was too long to be drawn out without lifting the gun, the boat had to be pulled about a mile into smooth water, under the lee of the breakwater, to dismount the gun.

Buffers.

6. Fired six rounds with 11 buffers in rear of connecting bolt, and four in front, compressors slack; the recoil was very sharp, and the jump considerable.

App. No. 6.

considerable. Buffers were compressed 12 ins., and the gun ran out violently. Discontinued the firing, owing to the rear bearing of the buffer-rod cutting down into the fir slide, the thickness of the wood being only 1½ ins.

Buffer-rod.

7. On removing the slide, found the fighting chock split, and drawn backwards; the pivot bolt was bent. The buffer-rod was likewise bent upwards about one inch from the horizontal line.

The injury may, however, have been partially caused by the gunboat coming in collision with the muzzle of the gun when coming alongside, in the heavy swell existing at the time.

Practice.

8. January 29th. — The slide having been strengthened by lining the groove with sheet iron, about 12 ins. in length, for the rear bearing to work in, 17 rounds of shot were fired with 5° of elevation.

Three rounds were fired with the compressor bore taut, having 11 buffers in the rear and four in the front. A 6-ins. breeching was taken up so as to bear a strain when the buffers were partially compressed, it being desirable to bring a portion of the strain on the stem of the boat and the upper part of the carriage, as well as to relieve the pivot of the fighting chock.

The buffers were compressed 10 ins., but the gun did not recoil to within 4 ins. of the original mark, nor did the buffers act when the compressor was eased. The gun had to be run out with side tackles.

Crew not been Incommoded by Recoil.

9. The recoil was not very violent, nor were the men standing on the thwarts, or the coxswain in his seat, unusually incommoded. Three rear buffers were now removed (leaving eight), using the same length of breeching and compressor as before.

Practice with Buffers removed.

Fired two rounds; found the recoil not so sharp, and the jump less. Took off another rear buffer, and fired four rounds; the same length of breeching, with the compressor slack; the gun jumped more, and the reaction was not sufficient to run it out.

Practice with Buffers replaced.

10. One rear buffer was replaced, the compressor slack, and the breeching unaltered. Eight rounds were fired, quick firing, with 5° elevation; the recoil was not very violent, but the gun jumped considerably, bending the buffer-rod, so that, at the eighth round, the slide was split, owing to the pressure on the rear bearing, caused by the centre of the rod being bent upwards.

The nut connecting the compressor flap to the carriage was carried away; the boat's stem, the pivot, fighting chock, and breeching showed no sign of weakness.

Had the compressor been taut, the slide would probably have escaped injury, as it keeps the fore part of the carriage firmly attached to the slide.

11. Although 23 rounds may be barely sufficient to confirm an opinion, I am strongly inclined in favour of the buffer principle. With a few slight alterations and suggestions herein mentioned, I think it can be made to answer; and, even should it fail, the slide and carriage will remain ready for use in case of any accident to the buffers.

Rollers proposed.

12. A larger slide than the usual service slide for the 24-pounder howitzer appears unnecessary for this gun; the labour of running out is very great; this could be remedied by the use of rollers and levers similar to those in use for pivot guns.

Proposed Alteration in Buffer-rod and Slides.

13. When the buffers are used, the rod should be 12 ins. longer, with two or more supports about the centre; they should work with two metal shoulders attached to the brass disc, bearing on a metal plate on the top and bottom of the slide; that on the upper surface being let in sufficiently deep to allow the carriage to recoil over it.

The whole should have rounded bearings, and work freely. This would add to the strength of the slide, and prevent the injury already alluded to. The slide, as at present fitted, is too weak, and should be made of harder wood.

Grease.

14. As grease is apt to destroy vulcanized india-rubber, and large quantities escape from the breech when using greased wads, I feel satisfied that, unless some plan is adopted for covering the india-rubber buffers, they will soon be destroyed and rendered useless.

Alteration in Pivot Bolt.

15. An alteration is required in the pivot bolt to enable the buffer bar to be connected without lifting the gun, in consequence of the length of the bolt.

16. Should the War Department approve, these alterations might be made in the gun wharf at this port, and the trials repeated.

Remarks on the Gun.

17. It may not be out of place to remark in this report that the breech piece is apparently constructed to be used without primers, but the frequent misfires rendered it necessary to use them. Friction tubes were used in the commencement of the experiments, but the detonating hammer having been left inadvertently on the gun, the recoil caused it to fly over, and thereby broke the crutch of the friction tubes; the crutch was removed, and detonating tubes used.

No ranges were obtained for this gun of any value, as the motion was very considerable.

(signed) *A. W. Jerningham,*
Captain, H. M. S. "Cambridge."

Vice Admiral
Sir Houston Stewart, K.C.B.,
Commander in Chief, Plymouth.

— No. 4. —

ARMSTRONG PROJECTILES.

H. M. S. "Cambridge,"
Sir, Devonport, 16 February 1861.

IN reference to your memo. of the 13th instant, directing me to report, for the information of the Lords Commissioners of the Admiralty, "whether, from my own experience, or from that of the officers who have seen anything of the firing of the Armstrong guns, I have any reason to believe that particles of the lead which cover the projectiles are so scattered when the gun is fired, that it would be dangerous, if not impossible, to use these guns to cover the landing from boats, or for the protecting the advance of men under their immediate fire;"

I beg to state that particles of lead have parted from projectiles through negligence in sponging, and when the bore of the gun has been allowed to rust.

I should have no hesitation to allow the Armstrong gun to be fired over me in landing from boats.

I have further to state, that in trying the experiment with the 25-pounder in the boat, she was fast to a buoy within 50 yards of the line of range of three Armstrong guns, and one 68-pounder; fearing a premature burst from any of these guns, I stopped the shell firing, but continued that with shot, which lasted about five hours, and I saw no cause to induce me to shift the berth of the boat. The guns were firing at a range of 2,400 yards at the same object at which I was firing the boat's gun at 700 yards.

I herein enclose the reports of three gunnery officers who had some considerable experience with the guns, as well as that of the gunner who has the special charge of the Armstrong instruction when firing.

I have, &c.
(signed) *A. W. Jerningham,*
Captain.

Vice-Admiral
Sir Houston Stewart, K.C.B.,
Commander in Chief.

Lieutenant William Dawson states:

1st. Neither at Shoebury, nor in our practice in the "Redwing," or at Bovisand, have I ever seen the lead strip off the Armstrong projectile.

2d. Nevertheless, I am aware that the lead has stripped off and been projected nearly at right angles to the range.

3d. On these occasions, there appears seldom to have been any cause referable to the mode of using the gun.

4th. On one or two occasions the stripping off of the lead has been attributed to bad sponging; but I think that reason to be insufficient, having seen ten rounds fired without sponging at all, when the fouling in bore seemed to be very little more after the tenth round than after the first round, and when using greased wads 102 rounds were fired without sponging, and though the shot had then a tendency not to take the rifling, no lead was observed to come off.

5th. It is more probable that the lead coating has been either originally imperfect, or its holding power has deteriorated whilst laying in store for some lengthened period.

6th. When the lead does strip off, it is likely to be most injurious to any persons in advance of the gun, more particularly if they are to the left of the range.

7th. It becomes a matter of consideration whether this accident occurs sufficiently often to militate against the general service of the gun in battery, or in boats advancing in an irregularly formed line abreast.

8th. As far as our experience in firing enables me to form a judgment, I consider that the casualties from bad stripping off may be regarded as amongst the ordinary chances of war.

Lieutenant J. P. Jones, Parry, and H. Nicholson, state:

1st. As far as our experience allows us to judge, we are of opinion that the Armstrong gun may be used with safety for covering the landing or clearing the front of troops.

2d. If the grooves are kept moderately clean, either by using greased wads, or by occasional sponging (once every two or three rounds), we have never observed any particles of lead to strip off the shot.

3d. When the jacket has stripped off the shot, (owing to foul grooves) it has invariably fallen from 300 to 400 yards to the left, in a direction nearly at right angles to the line of fire, and this without materially altering the direction of the shot, in fact, twice the rock at which we were firing at 2,400 yards was struck. We are, therefore, of opinion that troops to the front of the gun are not in danger of being struck by any particles of lead.

Mr. Robert Kitchener, Gunner, 3d Class, conducting the Armstrong Exercise, states:

That if the gun be clean, lead will not strip off.

Has seen 1,500 rounds fired without knowing shot to strip.

On one occasion, after gun had been left dirty after practice, and then exposed to three weeks of wet and boisterous weather, the lead from the first six shots did strip, and shell did not obtain a greater range than 600 yards, although elevation was given for 2,000 yards.

Gun fouls when lubricating wads are used, especially with the 12-pounder, there not being sufficient heat from the charge to dissolve the wad.

When grooves are kept clean, the gun can be depended upon.

— No. 5. —

GREASED WADS.

H. M. S. "Cambridge,"
Sir, Devonport, 28 March 1861.

IN reference to Sir Thomas Pasley's memo., dated 19th October 1860 (Vice Admiral sick), suggesting that 200 cartridges, having the greased wads choked in them, should be supplied to H. M. S. "Cambridge," under my command, for trial, I have the honour to report, that having fired 73 rounds, using those wads, I find that the bore is lubricated by them sufficiently to obviate the necessity of sponging the gun more than once every 20 or 30 rounds, and although they do not lubricate so efficiently as when entered separately, they are much more convenient for loading.

App. No. 6.

In using these wads separately they often capsize in the chamber.

With regard to the stowage, &c., of the lumber, I have no opportunity of judging.

The report has been delayed owing to the ammunition not being supplied until the 22d December 1860, and continued rough state of weather.

I have, &c.
(signed) *A. W. Jerningham,*
Captain.

Vice Admiral
Sir Houston Stewart, K.C.B.,
Commander in Chief.

— No. 6. —

SHORTENED 12-POUNDER ARMSTRONG GUNS.

H. M. S. "Cambridge,"
Sir, Devonport, 21 May 1861.

IN reference to your memo. of the 18th instant, communicating to me that Lord Herbert was anxious that an early decision should be arrived at as to the pattern for shortened 12-pounder Armstrong guns, and further referring me to your memo. of the 9th March last, informing that such gun would be sent to this port for trial against a 12-pounder Armstrong gun now in use, and that I should report as soon as possible which of the guns I considered best adapted for naval service;

I have the honour to report that, after a trial of the shortened gun afloat and ashore, I have every reason to be satisfied with its working in the boat and its accuracy of fire from the shore; but when compared with the long 12-pounder in accuracy of practice, there is a greater uncertainty of range with the short guns than with the long one, when practising at the Shagstone Rock from Bovisand Pier, a distance of 2,300 yards; the practice with the long 12-pounder is universally most accurate, whilst I have found that the short 12-pounder, with scarcely any atmospheric influence to affect the projectile, was not so accurate at the same range. The weight of the gun is 8 cwt. 17 lbs., that of the long gun 8 cwt. 2 qrs. 14 lbs., making only a difference of 53 lbs., and a foot in length; unless, therefore, there should be some substantial reason for substituting the short for the long gun (which, I confess, I cannot divine), I should recommend the adoption of the long 12-pounder, it being, in my opinion, the most accurate piece of ordnance that I have ever witnessed.

This report would have been sent in earlier, but the gun was only received yesterday, and the experiments were made yesterday and to-day.

I have, &c.
(signed) *A. W. Jerningham,*
Captain.

Vice Admiral
Sir Houston Stewart, K.C.B.,
Commander in Chief.

— No. 7. —

GUN CARRIAGE FOR 20-POUNDER ARMSTRONG.

H. M. S. "Cambridge,"
Devonport, 19 September 1861.

Sir,

IN compliance with your memorandum of the 24th ultimo, directing me to report on an improved gun carriage for the 20-pounder Armstrong, I have the honour to acquaint you, that trials were made on two occasions on board the "Redwing" gunboat, with 25-pounder projectiles and 2 lbs. 8 ozs. charge; 23 rounds were fired.

On the first occasion the wind was fresh, with a heavy broadside swell; gunboat rolling heavily. The motion of the vessel did not in any way appear to affect the stability of the gun and carriage which were placed in the bow.

On the second occasion the weather was fine, the water smooth.

On both occasions the recoil was most violent, and to such an extent that had the breeching been carried away, further accident must have occurred.

On the first occasion the gun in recoiling was thrown down with the muzzle touching the deck, and had to be replaced; it did not fall over.

On the second occasion in recoiling it reared up on the rear chock, and remained nearly perpendicular; it had to be replaced.

The fore trucks require to be placed considerably before the trunnions, as the whole weight of the gun rests on the fore trucks, rendering the rear chock comparatively useless for friction, the gun having no preponderance beyond the breech screw and vent piece.

It would be advisable that the breeching should be brought further back, and tried with or without breeching-rings or breast frappings.

I beg to suggest that this report may be forwarded for Captain Hewlett's remarks and suggestions.

I have, &c.
(signed) *A. W. Jerningham,*
Captain.

Vice-Admiral
Sir Houston Stewart, K.C.B.,
Commander in Chief.

— No. 8. —

9-POUNDER ARMSTRONG GUN REDUCED FROM A 12-POUNDER.

H. M. S. "Cambridge,"
Sir, Devonport, 6 May 1862.

WITH reference to your memorandum of the 16 February 1862, I have the honour to report the result of the practice we have had with the 9-pounder Armstrong gun, reduced from a 12-pounder.

Its range and accuracy as far as 2,300 yards, I consider very satisfactory.

It was found to require about half a degree more elevation at distances varying from 800 to 1,200 yards.

At 2,300 yards (being the extent of our range) the elevation allowed was 6° 45′ against 6° 9′, which is the elevation required for a 6-pounder gun.

Its recoil appears to be considerably less than the 12-pounder.

Its new arrangements of the sights I consider improvements.

I have, &c.
(signed) *A. W. Jerningham,*
Captain.

Vice-Admiral
Sir Houston Stewart, K.C.B.,
&c. &c. &c.
Commander in Chief.

App. No. 6.

— No. 9. —

TRIAL of CARRIAGE fitted with Cast-iron Flanges, instead of Wrought-iron Straps.

H. M. S. "Cambridge,"
Devonport, 23 February 1863.

Sir,

IN accordance with your memorandum of 9 July 1862, I have caused 300 rounds to be fired from a 110-pounder Armstrong gun mounted upon a garrison sliding carriage fitted with cast-iron flanges, instead of wrought-iron straps; and I attach hereto my report of the result, and also a Table showing the details of the experiments, with general remarks upon the firing.

I have, &c.
(signed) *L. G. Heath,*
Captain.

Vice Admiral
Sir Houston Stewart, K.C.B.,
Commander in Chief.

REPORT.

THE experimental gun-carriage differs from the old one in the mounting of the front rollers and their attachment to the carriage, and in having this mounting of cast; instead of wrought iron.*

These front rollers, upon whichever plan fitted, are not intended to touch the slide during the recoil, and as they come into play only whilst the gun is being run out, I am of opinion (which opinion has been confirmed by these experiments) that no amount of firing is likely to affect them. Comparing the two plans, I find them equally efficient for working the gun; but as cast-iron when struck by shot breaks into many small fragments to the great danger of those surrounding it, I think it should not be used in gun carriages, and on that account I do not recommend the adoption of the new plan, notwithstanding its being (as I am informed) somewhat cheaper than the other.

Details of Experiments.

The gun was a 110-pounder Armstrong, marked RGF 147 1861 and was fired between the 9th and 18th February from the "Redwing" gunboat under weigh near the Plymouth Breakwater.

The charge used throughout was 12 lbs., and the new lubricating wads attached to the cartridge were used, except for a very few rounds.

State of Sea.	Number of Rounds Fired.	Average Time between Shots, deducting accidental delay.	Elevation, &c.	REMARKS.
Moderate. Gunboat rolling 2° to 4° each way.	40 shot	-	Horizontal	Firing as fast as possible without taking aim.
	23 shot	-	10° elevation	
	67 shot	2 min. 3 sec.	Extreme elevation (17°)	
	35 shot	-	Extreme depression (18°)	
	10 shot	-	Extreme elevation (17°)	Gunboat heeled over 5° away from firing side.
	88 shot	Time not taken, as the range was frequently foul	From 1° to 9°	Aiming at target.
	47 shell, with old pattern time fuze		From 3° to 6°	Aiming at target.

30 Rounds running in and out as violently as possible, with 40 men upon the falls.

In the course of the firing two vent-pieces were rendered unserviceable, as shown in the photographs,† and a third temporarily disabled by breaking the guide crutch. Both handles of breech lever broke short off. The chain of the key of the bed carried away. The left deflection screw was disabled by the concussion.

Out of the 47 shells fired, 19 did not explode. [This pattern of fuze has been already condemned by the War Office.]

General Remarks and Recommendations.

The gun worked smoothly and well. The bore was kept well cleaned out by the lubricator wads.

The permanent disabling of two vent-pieces, and the temporary disabling of a third, shows that the allowance of spare vent-pieces should on no account be diminished, and that the utmost care should be taken that all vent-pieces should continue to be made exactly the same in pattern so as to fit any gun.

The handles of the breech lever should be stouter.

This gun is so evenly balanced, that when run out with a jerk with extreme depression the muzzle cants downwards as far as the port will allow it. Perhaps raising the trunnions a little higher would be the best remedy for this defect.

These experiments show that, even with a well-trained gun's-crew, this gun cannot be fired at a mark at sea quicker than once in two minutes.

* Sketch showing the difference sent in original.

† Sent with original.

App. No. 7.

Appendix, No. 7.

DRAWINGS delivered in by Lieutenant Colonel E. M. Boxer, 23 March 1863. (*See opposite.*)

App. No. 8.

Appendix, No. 8.

PROCEEDINGS of a COMMITTEE of ARTILLERY OFFICERS assembled at the Horse Guards, on the 17th November 1862, by order of His Royal Highness Field Marshal Commanding in Chief, with the concurrence of the Right Honourable the Secretary of State for War.

Brigadier General ST. GEORGE, C. B., President.
Colonel A. J. TAYLOR, R. A.
Colonel C. BINGHAM, R. A.
Major C. F. YOUNG, R. A., Secretary.

THE above Committee having assembled, the observations of His Royal Highness Field Marshal Commanding-in-Chief, as well as letters and reports from different stations, were laid before them; from which it appeared that a number of the service field guns had become seriously injured in carrying on the ordinary instructional practice, and that other accidents had occurred to the new equipments.

Colonel Bingham further informed the Committee, that His Royal Highness was anxious that the causes of the accidents above referred to, as well as all other failures with the Armstrong service guns, should be investigated by them.

After some conversation, the Committee resolved to inquire into the nature and causes of the following accidents and injuries recently sustained by the Armstrong equipments:

1st. The six 12-pounder guns, which suffered so much from ordinary practice at Shorncliffe.

2d. The horse artillery guns at Woolwich requiring repair after the ordinary practice at Shoeburyness.

3d. The explosion of a concussion fuze in a limber box in Dublin.

4th. The reported unmanageable recoil of the 110-pounder gun.

5th. A 9-pounder horse artillery gun at Dorchester, injured at practice.

Colonel Bingham having offered to ascertain if the six 12-pounders injured at Shorncliffe were still at that station, or to whence they had been removed, it was decided the Committee should examine the injuries these pieces had sustained, on Thursday the 20th November. The Secretary was directed to invite Mr. Anderson, the Assistant Superintendent Royal Gun Factories, to be present at this examination, as the guns in question were manufactured in his department.

20th November.

THE Committee re-assembled at Shorncliffe, on the 20th November, for the purpose of inspecting the defective guns; Mr. Anderson also attended, and furnished the history of these pieces.

History.—No. 332 gun was first examined. "It was bouched throughout with a mild iron, and a screw 3 inches long formed at the muzzle end, in order the better to secure it."

Injuries.—About 3 inches of the thread is broken off the breech screw, and it cannot be got into the gun. The female screw is uninjured, as another breech screw worked in the gun with facility. This gun has fired about 173 rounds.

Recommendation.—It is recommended that the defective breech screw, on arrival at Woolwich, be submitted to a careful examination in the Royal Gun Factories, and a report made by the Assistant Superintendent as to the probable cause of the injuries it has received.

History.—No. 198 gun. "It was bouched throughout with a steely iron."

Injuries.—The part of the gun behind the trunnions has receded from the remainder of the gun ·8 inch, carrying with it the lining or bouche a distance of ·6 inch.

The separation was first observed at the 19th round. Seven rounds were afterwards fired; the separation increasing each round.

Recommendation.—Recommended that this gun be cut through the axis longitudinally for careful examination as to the cause of failure.

History.—No. 190 gun. "It was bouched throughout with a very fine steely iron."

Injuries.—At the 12th round, from this gun the bouche was observed to project slightly from the muzzle. The projection increased with the firing, and, at present time, after 34 rounds, it is ·14 inch from the face of the piece. A corresponding vacancy is left behind.

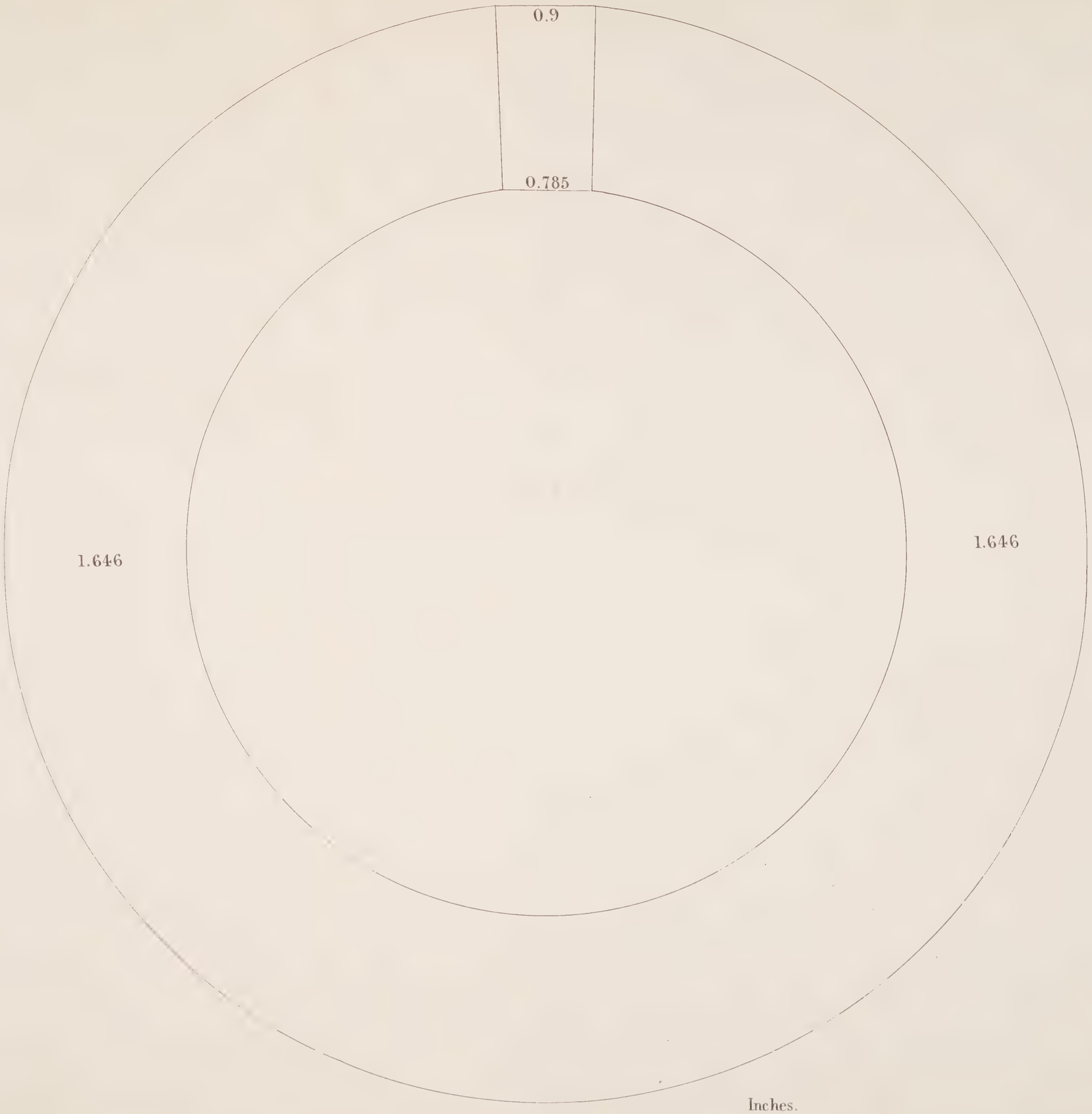
History.—No. 287 gun. "It was bouched throughout with a mild iron bouche."

Injuries.—Seventeen rounds were fired from this gun, when it was considered unsafe, from a long crack in the coil behind the trunnions.

It was first observed at the 10th round, and increased with the practice. The crack extended from the breech to the trunnions, and is ·1 inch in

Register N^o 2.

SECTION OF A 10 INCH COMMON SHELL. LAND SERVICE.



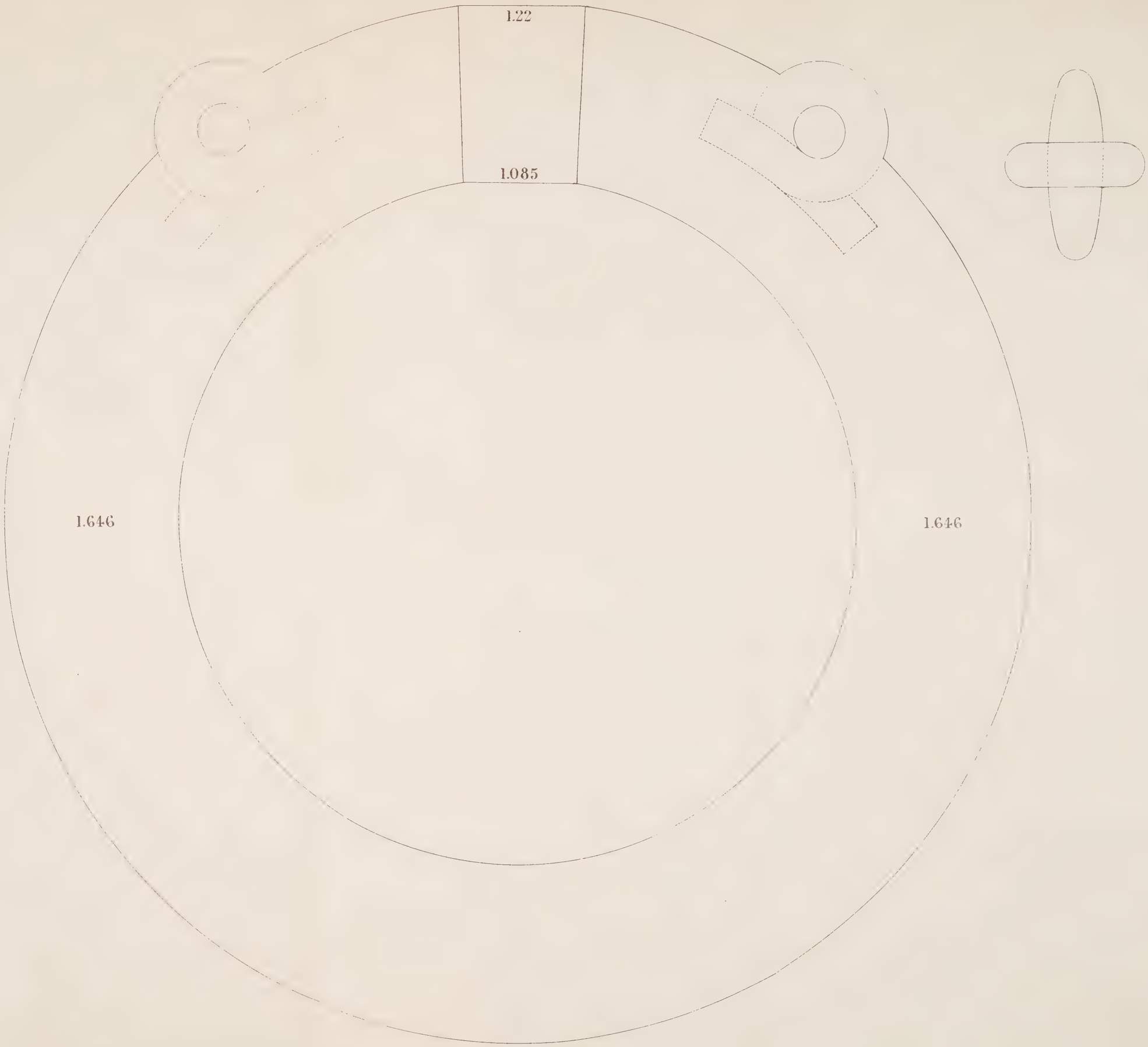
		Inches.
Deviation in thickness under or over		0.164
Thickest side not to exceed		1.81
Thinnest side not to be less than		1.482
Exterior Gauge	*High*	9.88
	Low	9.8

R^l Carriage Depar^t
Feb^y 1855.

N^o 487. Ordered, by the House of Commons, to be printed, 23. July. 1863

Register N°. 3.

SECTION OF A 10 INCH SHELL FOR MORTARS.



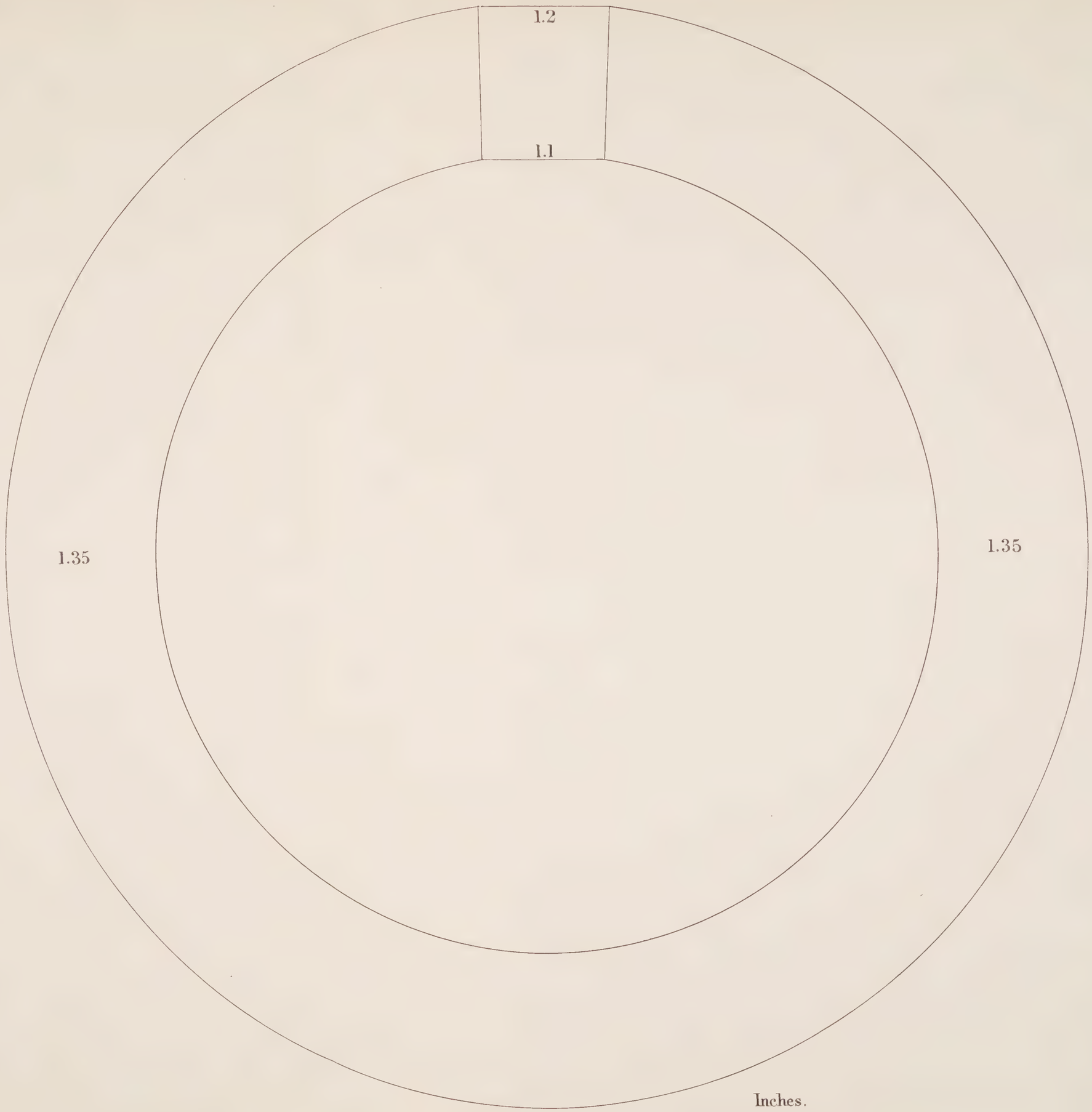
		Inches.
Deviation in thickness under or over		0.164
Thickest side not to exceed		1.81
Thinnest side not to be less than		1.482
Exterior Guage	*High*	9.88
	Low	9.8

R.l Carriage Depart.
Feb.y 1855.

N°. 487 Ordered, by the House of Commons, to be printed, 23 July 1863

Register N°. 4 & 5.

SECTION OF A 10 INCH NAVAL SHELL, OR HOLLOW SHOT FOR LAND & SEA SERVICE.



		Inches.
Deviation in thickness under or over		0.2
Thickest side not to exceed		1.45
Thinnest side not to be less than		1.25
Exterior Gauge	*High*	9.875
	Low	9.825

R^l. Carriage Depar^t.
Feb^y. 1855.

N° 487. Ordered, by the House of Commons, to be printed, 23 July 1863.

in width, 1·1 inch in depth. In consequence of this injury, the shell could be forced 5 inches further up the bore than was possible at the commencement of the practice.

Recommendation.—It is recommended that this gun be proved to destruction with service charges. The defective coil to be afterwards tested as to the quality of the iron.

History.—No. 315 gun. From defect in the material, this gun was bouched before proof 12½ inches from the vent-piece.

Injuries.—About 170 rounds were fired when a large flaw was observed in the bore, about 18 inches from the muzzle; 30 more rounds were fired, the flaw increasing each round. The shells were checked by the flaw in their passage through the bore, and, in many instances, they burst in consequence.

History.—No. 160 gun. "It was bouched throughout with a mild iron bouche, and a screw 3 inches long formed at the muzzle end, the better to secure it."

Injuries.—This gun was fired about 200 rounds. Several cracks have appeared on the exterior running round the piece. These increased in size with the number of rounds. In washing this gun, water finds its way through the largest of the cracks.

Recommendation.—It is recommended that this gun be proved to destruction with service charges.

25th November.

The Committee re-assembled at Portsmouth on the morning of the 25th November, and proceeded to the Southsea beach to witness the practice with the guns of the I. and K. batteries of the 4th Brigade Royal Artillery.

The firing commenced at four minutes to 11 o'clock a.m., and the first gun that expended its ammunition, viz. 123 rounds, ceased to fire at 1° 5″ p.m.; the practice concluded at 1° 14″ p.m. Vessels crossed the range on two occasions, causing a stop to the firing for periods of 14 and 16 minutes respectively. The targets upon which the guns were laid were anchored at a distance of about 2,400 yards. It was found difficult to load with many of the shells, owing to the lead having "set up" at the base. This is doubtless caused by transport. A number of the fuzes were very bad, bursting the shells prematurely, or at very short distances from the guns. The lead was observed to strip from some of the shells.

Towards the conclusion of the practice many of the breech screws worked so stiffly, that it delayed the loading very considerably; on one occasion 10 minutes were occupied in screwing up the breech, owing to this circumstance. This was caused by dirt and cake getting into the threads of the screws, and might have been obviated by occasionally pouring a little water over them, which dissolves the cake and makes it act as a lubricant.

One vent-piece broke up the first round it was used, a large piece of the upper part of it being projected about 30 or 40 paces from the gun. The number one of the gun assured the Committee that the gun had been properly screwed up before firing. This vent-piece is made of steel, and shows by its fracture an inferior quality.

Two drip-pans were blown away. Three of the guns show signs of injury, two of which are of a serious nature.

The following gives the history of the guns, and the result of their examination after the practice.

I. Battery.

History.—No. 291 gun. "It was bouched before proof 16¼ inches from vent. After proof the powder-chamber appeared clear. Slight flaw 19 inches from vent sent up."

Examination.—Fresh flaw 1″ left of up; rifling slightly damaged right of up. Wrought-iron vent-piece requires facing.

Both vent-pieces were used, the first being changed at the 50th round. The breech-screw stuck about the 45th round, but worked well after being washed with water.

History.—No. 298 gun. "It was bouched before proof 8¾ inches from vent, and after proof appeared perfect."

Examination.—One vent-piece requires new copper. The breech-screw stuck once, but worked well after being oiled. The same vent-piece used throughout the practice.

History.—No. 313 gun. "After proof some tool-marks appeared in powder chamber."

Examination.—One vent-piece requires facing. The copper bouche of the vent hole of the other vent-piece is driven back slightly. Breech-screw, 1½ inch of the end of thread broken. The vent-piece was not changed until the 90th round. After the 60th round the breech-screw stuck, but worked well after it was oiled.

History.—No. 121 gun. "The bore failed at first proof. It was then bouched throughout with iron, and three inches screwed-plug at the muzzle. After the second proof it appeared perfect."

Examination.—Rifling slightly damaged at 11 to 14 inches all round, by a shell bursting in the bore. Two and a half inches of the end of breech-screw broken. Used both vent-pieces alternately.

History.—No. 267 gun. "After proof it appeared perfect."

Examination.—The gun is perfect; one vent-piece only used.

History.—No. 234 gun. "After proof flaws were discovered in powder chamber, and also slight flaws 17″ up and 39″ down. It was then bouched 15⅜ inches from the vent, and after proof the powder chamber was clear, and the flaws mentioned above did not appear to have increased."

Examination.—One vent-piece requires facing. Used both vent-pieces alternately, the first change being made at the 25th round. Breech-screw removed three times to clean.

K. Battery.

History.—No. 153 gun. "It was not bouched."

Examination.—Breech copper expanded. Breech-screw damaged; all the threads broken. One vent-piece (steel, No. 701) much broken, and the upper part blown away. Female screw damaged. Crack in breech-piece behind the water-hole. This gun only fired 58 rounds. The vent-piece changed at the 50th round.

Recommendation.—This gun should be sent to Woolwich for examination and repair.

History.—No. 135 gun. "It was bouched."

Examination.—

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Examination.—One vent-piece only used. It require new copper; 2½ inches of the breech-screw injured; shifted slightly behind the trunnions.

History.—No. 138 gun. "It was not bouched."

Examination.—Two end threads of breech-screw broken. One vent-piece much injured. Only one vent-piece used during the practice.

Recommendation.—The injured vent-piece should be brought to Woolwich for further examination.

History.—No. 250 gun. "After proof it appeared perfect."

Examination.—Two flaws through the gun at 39 inches right of up. The fouling came through during the practice. One vent-piece requires refacing.

The gun shifted a little behind the trunnions. One vent-piece only used.

Recommendation.—This gun should be brought to Woolwich for examination, and further tested by firing with service charges.

History.—No. 242 gun. "After proof a slight flaw was discovered in powder chamber."

Examination.—Drip-pan blown away during the practice. One vent-piece requires a new copper.

History.—Three vent-pieces were used, No. 193 gun. "After proof it appeared perfect."

Examination.—Three bevil drawn from under trunnion loop, ·05-inch. Two threads of breech-screw broken. Drip-pan blown off during the practice. One vent-piece too much worn for refacing. Only one vent-piece used during the practice.

RECAPITULATION of the more serious injuries sustained by the Guns, &c., of the "I." and "K." Batteries of the 4th Brigade Royal Artillery.

"I." BATTERY.

1. Two breech screws injured.

2. The rifling of two guns slightly damaged.

"K." BATTERY.

1. Two guns seriously injured, requiring to be sent to Woolwich.

2. Four breech-screws injured.

3. One vent-piece broken in pieces; part blown away.

4. One vent-piece injured from having fired too many rounds from it without facing the copper.

5. Two drip-pans blown away.

From the history of the guns used at the above practice, as furnished by the Assistant Superintendent Royal Gun Factories, it would appear that four had been lined before issue. These had been recently supplied to "I." Battery to replace lined guns which were not considered strong enough for service. The guns in question, viz., Nos. 121, 234, 291, and 298, appear to have stood the firing well on this occasion.

Practice from 110-pounder Armstrong Guns on Dwarf Traversing Platforms.

At the conclusion of the practice of "I." and "K." Batteries, the Committee proceeded to Lump's Fort, to witness the firing of two 110-pounder Armstrong guns mounted on dwarf traversing platforms.

Three rounds were fired from each gun, and the recoils were as follows:

No. 1	-	-	-	-	8	feet.		
„ 2	-	-	-	-	7	„	10	in.
„ 3	-	-	-	-	5	„	9	„
„ 4	-	-	-	-	8	„	7	„
„ 5	-	-	-	-	5	„	2	„
„ 6	-	-	-	-	5	„	5	„

The compressors worked easily and well, and afforded a ready and efficient means of keeping the recoil within the necessary limits.

It should be distinctly understood that the compressors are not intended to check the recoil absolutely, for then an injurious strain is exerted on the carriage, platform, and racers; but they are merely for the purpose of keeping the recoil within reasonable limits.

The 110-pounder, when fired with the service charge, should be allowed to recoil between seven and eight feet.

8th January 1863.

Horse Artillery Guns at Woolwich.

The Committee having re-assembled at the President's Office, Royal Arsenal, on the 8th January, made inquiries respecting the injuries said to have occurred to the Horse Artillery guns during the instructional practice at Shoeburyness.

It would appear that the injuries in question are generally of a trivial nature, and resulting from the premature explosion of the shells in the bores. The necessary repairs can be effected by the battery armourers.

Recommendation.—In two of the guns examined there are small openings of the coils, and, as these openings have increased with the number of rounds fired, it is recommended that these two guns be submitted to a careful examination in the department of the Inspector of Artillery. The guns are No. 2 of "F." Battery, the coil opening about 2 inches from the muzzle, and No. 33 of "D." battery, the coil opening about 13 inches from the muzzle.

Small openings of the coils in several of the other guns were observed, but as these had been noted before the practice at Shoeburyness, and did not appear to increase in size, they are not likely to interfere with the efficiency of the guns.

9-Pounder Horse Artillery Gun at Dorchester.

Although the Committee have not yet had an opportunity of examining this gun, which belongs to "B." Battery Horse Brigade (No. 26), they have carefully read the documents relating to it, and are satisfied that, as with the guns just referred to of "F" and "D" Batteries, the failure has arisen from defective manufacture.

Recommendation.—As this gun may be considered unserviceable, it should be replaced by an efficient one, and then returned to Woolwich for careful examination, in the department of the Inspector of Artillery.

Rapid firing 100 rounds from the 9-pounder guns of "A." and "I." Batteries Horse Brigade.

The reports of the experimental practice from the

the guns of "A." and "I." Batteries Horse Brigade were read by the Committee.

This practice was carried on most carefully near Dublin, and the result may be considered highly satisfactory, as regards the strength and general efficiency of the guns.

The only injuries they sustained were of the most trivial character, being slight indentations in the bores owing to the failure of the time fuzes, which were of the obsolete pattern.

Towards the conclusion of the practice the elevating screws of "I." Battery became very difficult to work, requiring oil; and, in one instance, the breech-screw was reported to work stiffly. As already stated, this latter might have been obviated by the occasional use of a little water.

The Explosion of a Concussion Fuze in a Limber Box.

The papers relating to the accidental explosion of a concussion fuze in a limber box in Dublin, having been laid before the Committee and carefully considered, the Committee are of opinion, that this accident, which is an isolated instance of the kind, arose entirely from the great play allowed to the fuze, during the rapid movement of the limber in which it was carried. The old pattern fuzes, of which it was one, would always be more or less liable to these contingencies, provided they were not better secured than appears to have been the case in the instance recorded.

The new pattern fuzes are of a much safer construction, and little liable to an accident of this description. The Committee are, nevertheless, of opinion, that neither concussion fuzes nor other "materiel" containing detonating composition, should be allowed to travel loosely in boxes; for, even supposing there be no danger from premature explosion, they are liable to sustain disarrangement of the parts or external injury.

The fuzes are now packed in separate pigeonholes in the fuze boxes, which prevents any play in transport, and precludes the probability of either accident or injury of a mechanical nature.

The Committee are of opinion, that if proper care had been taken, this accident would not have happened.

Conclusion.—In concluding this Report, the Committee beg to submit the following, as the causes of failure in the new artillery equipments, viz.:—

1st. Bad and irregular manufacture of supply.

Patched-up guns should not be issued for service. The Ordnance Select Committee have already recommended that a portion of these guns should be issued to Shoeburyness, where they can be watched.

General Inspection of Artillery "Materiel."

It would seem also desirable that all "materiel" should be submitted to a careful inspection, other than that of the manufacturer, before being admitted into the service. The guns that have recently failed, were all manufactured in the Royal gun factories, and received into the service without passing through the department of the Inspector of Artillery. Moreover, owing to the circumstance of the Inspector of Artillery being unacquainted with the history of the guns manufactured in the Royal Arsenal, that officer sent, by mistake, to Portsmouth, just before the late experiment, four patched-up guns, to replace guns of a similar description, considered unfit for the trial. Such a blunder could scarcely have occurred, had the guns passed through his department before admission into the service.

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2d. The transition state of artillery "materiel," which is still almost in an experimental stage.

Such a radical change in artillery naturally requires time to perfect it, and in ordinary cases the several natures of Armstrong guns, with their various details, would not perhaps have been admitted into the service until thoroughly tried under all circumstances. Other nations had, however, adopted rifle ordnance, and it was necessary that England should at once select a system, the best that presented itself, and improve and perfect it afterwards.

3d. The superior refinement of rifled arms.

This will always cause them to contrast unfavourably in handiness and ability to bear rough usage with the old smooth-bored guns.

4th. The adoption of the breech-loading system:—

This unavoidably causes much complication, and necessitates a large amount of care and intelligence in its use.

5th. The want of intelligent supervision:—

Accidents complained of and reported do not occur at Shoeburyness; there everything goes straight. Neither do accidents occur on board the gunnery ship at Portsmouth. At these places, nevertheless, the men employed about the guns are often recruits sent for instruction, who have never seen the arms before. The officers, however, thoroughly understand their duty, are acquainted with every detail connected with it, and check every tendency to mistake or neglect on the part of the men. The vent-piece fails because the breech-screw has not been screwed home, and every accident may be traced to some neglect. At the experiments at Portsmouth the Committee witnessed, at one gun the vent-piece was changed every five rounds, because of its heat; and the man who served it had, notwithstanding, the skin burnt from his hand; at the next gun one vent-piece was used the whole practice, viz., 123 rounds, without any inconvenience, the non-commissioned officer having made use of water at hand to cool it when necessary. At one gun the breech-screw stuck more than once, and the gun was temporarily disabled by the useless force employed to send it home. At the next a few drops of oil were used every 20 rounds, and no difficulty was experienced. A little common sense seems all that is necessary. The heavy guns are reported to recoil violently, and in one instance a 110-pounder at Plymouth recoiled so violently as to upset; but in this case the use of the common means at hand would have prevented the accident if it had been desired. Compressors are issued for that purpose, the use of which can limit the recoil to any extent desirable, and the obvious expedient of sprinkling sand upon the platform, if it should be wet or slippery, will always keep recoil within moderate bounds.

6th. The insufficient instruction of men and officers.

The experiment the Committee witnessed at Portsmouth, where 12 guns were fired 123 rounds each, was conducted by two batteries that had never been through the school of gunnery, and success could scarcely be expected.

7th. The evils that have been investigated and remedied are not made known to the regiment.

It would be a great advantage if the Reports

App. No. 8.

of the Ordnance Select Committee on Artillery "materiel" were promulgated at once for general instruction. The regiment would then see the difficulties that had been overcome, and the means adopted to overcome them; the extent of trial and the result of experiments.

8th. Motives of economy that cause orders to be given for the continued use of "materiel" known to be unfit for service.

The ammunition used at Portsmouth in the experiment was all condemned and recommended to be withdrawn. The use of it, therefore, gave a wrong impression. The vent-pieces which were issued for the experiment by the superintendent of stores, were known to be defective, and were of an obsolete pattern. The Ordnance Select Committee had already recommended they should be withdrawn. It was not surprising then, that one should have blown. The whole of the "materiel" used in the experiment at Shorncliffe was obsolete, and no fair deduction can be made from its failure.

In conclusion, the Committee cannot too strongly urge the necessity of officers and men being fully instructed and constantly practised in the management and use of the new equipment. It is also important that batteries should always be supplied with ammunition and other "materiel" of the newest pattern.

(signed) *J. St. George,*
Brigadier General and President.
A. J. Taylor, Colonel, R.A.
Commandant and Superintendent,
Shoeburyness.
Chas. Bingham, D.A.G.

MINUTE by His Royal Highness the Field Marshal Commanding in Chief.

I FULLY concur in the recommendation contained in this report, and cannot too strongly urge upon the Secretary of State, the absolute necessity for having all guns and materials of war prepared in the Royal Arsenal of Woolwich, tested by regular proof, in like manner as all articles by contract are tested before they are admitted into the service. This is not now done, and though doubtless certain tests may be adopted, these are conducted by the various departments who are engaged in the manufacture of them, and not by the Inspector of Artillery.

I would also strongly urge the absolute necessity for not allowing articles of stores to be used of patterns which have been found in practice to be faulty. These should be withdrawn, and the recognised patterns sent out to replace them. Though this may lead to a certain amount of additional expense, I think it is one of those items of expenditure, the necessity for incurring which is so obvious, that I do not think there should be any hesitation with regard to it.

(signed) *G.*
3/2/63.

Appendix, No. 9.

COPY of the CORRESPONDENCE with reference to the Firing of Ten Rounds from ARMSTRONG GUNS, in addition to the Ordinary Proof before leaving the Arsenal.

The Under Secretary of State, War Office.

8, Great George-street Westminster.
21 April 1860.

Sir,

I BEG leave to recommend, that before any wrought-iron guns leave the Arsenal at Woolwich, they be tried with 20 rounds each under the supervision of a mechanic from the Gun Factory. I am inclined to make this recommendation, from the fact that if there be any concealed blisters in the bore, they will be elicited by a few rounds although they may have escaped detection on proof.

In applying this test to 12-pounders, I think they should be fired with 1¾ lbs of powder. In the case of 40-pounders, I think 6½ lbs. may be used.

I also consider that in proving these guns for the future, the same object may be attained by firing about 10 rounds of proof charges instead of only two.

I have, &c.
(signed) *W. G. Armstrong.*

MINUTE PAPER.

Inspector of Artillery,

WILL you have the goodness to report upon this?

(signed) *J. C. C.*
23/4/60.

As regards the wrought-iron guns placed in my hands for proof, I am held responsible for their fitness for the service, and I could not therefore allow of any other supervision but my own.

The proposal of firing 20 rounds from every gun before leaving the Arsenal, is in my opinion, unnecessary, and would involve much labour and expense.

I am of opinion, that the present method of proof by firing two charges, is a sufficiently severe test for these wrought-iron guns. To test them by firing five times the number of rounds (proof charges) would, in my opinion, be likely to injure them, and involve much additional labour and expense, for which I can see no good result.

(signed) *Alexander T. Tulloh,*
Colonel, R.A.
Inspector of Artillery.

Department of Inspector of Artillery,
Royal Arsenal, Woolwich,
26 April 1860.

Send this to Sir W. Armstrong, and request him to consider the above, as also the expenditure of shot which will be entailed by his proposal, and at this stage, when our store is nil. If absolutely necessary, it might probably be accomplished by the Royal Artillery at practice, a mechanic being present.

(signed) *J. C. C.*
28/4.

My opinion remains unchanged, that two rounds of proof charges are not sufficient to elicit blisters. Whether the 20 rounds be fired at practice or otherwise can make no difference, provided a competent person be present to look through the gun after each round.

(signed) *W. G. Armstrong.*
1/5/60.

Sir B. Hawes,
For decision.

(signed) *J. C. C.*
3/5

Captain Caffin,

This last minute differs from the letter herewith, to which I imagine Colonel Tulloh replies. In this minute, Sir W. Armstrong speaks only of "20 rounds fired at practice or otherwise." Considering that we are introducing a new arm, surely anything that can throw light upon its strength or discover any flaw in its manufacture should not be neglected. Before I pass this on, will you express your opinion? After proof, I suppose the Secretary of State, if he thinks fit, has only to order 20 ordinary rounds to be fired.

(signed) *B. H.*
3/5.

Sir B. Hawes,

I quite concur with Sir W. Armstrong in the advisability of firing the 20 rounds, in order to develope flaws should such exist at or near the surface of the bore. This may be considered apart from the proving carried on under the Inspector of Artillery, as these flaws would in no way weaken the construction, as I understand, but would have a tendency to strip the lead coating from the shell in its passage along the bore, and to destroy range and accuracy.

I think the 20 rounds should be fired by the Royal Artillery in practice, a mechanic being in attendance.

(signed) *J. C. C.*
4/5.

Mr. Herbert,

Approve? (signed) *B. H.*

I agree. (signed) *S. H.*
5/5.

Director of Store,

Inform Sir W. Armstrong, Colonel Bingham Royal Gun Factory, P. M. S. Woolwich, Inspector of Artillery.

(signed) *S. Wickens.*
7/5.

Ordered.

(signed) *J. C. C.*

App. No. 9.

(73—3—1003.)

Military Store Office, Woolwich, S.E.,
Sir, 9 May 1860.

ADVERTING to your letter, 8th inst. (73—3—963 P.), directing that after proof 20 rounds per gun for each of Armstrong guns, are to be fired by the Royal Artillery, a mechanic from the Royal Gun Factories being present.

I have the honour to request your orders how this service is to be performed, observing that the Inspector of Artillery has nothing to do with the proving of the guns made in the Royal Gun Factories.

Will you be good enough to say who is to demand the ammunition?

Are the guns to be in the charge of the Gun Factories while the trial is going on?

Are special carriages to be made, and if so upon whose orders, and how many?

I trust shot only may be used, since even if that is approved, the cost per gun will be increased for the smaller natures alone by 6 *l.* 10 *s.*; if shell is used, by 13 *l.* 10 *s.* For the larger natures the expense will be enormous.

In conclusion, I beg to submit that the guns be first issued to the parties who are to receive them, and that the 20 rounds per gun be then fired, and be counted a portion of the practice ammunition to be supplied.

A mechanic from the Gun Factories would, if necessary, be present.

I trust you will concur in this arrangement, in order to save expense, and not consider my suggestions unreasonable, when the whole supply of practice ammunition issued to a Field Battery of six guns is only 300 rounds, whereas this preliminary experiment will absorb 120.

I have, &c.
(signed) *H. W. Gordon.*

The Director of Stores, &c. &c.

For practice for Royal Artillery.

No; Royal Artillery.

No; the trial should be made by the Royal Artillery before finally taking the Battery over.
Shot only.

He is to be as ordered.

I told Captain Gordon that this was to be the arrangement, and now he writes up proposing it.

(signed) *J. C. C.*
14/5.

(73—3—1020.)

Military Store Office, Woolwich, S.E.
Sir, 15 May 1860.

ADVERTING to your letter, dated 14th inst. (73—3—1003 P.), I have the honour to state, I conclude, on the Armstrong's Battery being issued, I shall receive a demand from you to supply the usual 300 rounds of practice ammunition, with the exception that 120 cartridges will be made up with 1¾ lbs. of powder.

Also, that the officer commanding the brigade will inform the Superintendent, Royal Gun Factories, when he is prepared to commence the practice, upon which the mechanic will be directed to be in attendance.

I do not understand, however, how the service is to be performed when the Battery is supplied in Scotland or Ireland, but I suppose it is intended the mechanic is to proceed to the station when required.

The 20 rounds per gun could not be fired at Woolwich for a battery about to be sent to an out-station, since the men of the battery themselves would have to fire the same, it being a portion of the 300 rounds per battery allowed.

I have, &c.
(signed) *H. W. Gordon*, P.M.S.

The Director of Stores, &c. &c.

P.S. Will you call upon the Deputy Adjutant General of Artillery to demand the practice ammunition for the 6th and 4th Batteries, 4th Brigade, which batteries have been issued.

(signed) *H. W. G.*

(73—3—1022).

MINUTE PAPER.

I HAVE consulted Sir W. Armstrong and Colonel Bingham, and we consider that ten rounds per gun, with 1¾ lb. charges, should be fired from each gun before final delivery to the Royal Artillery.

This should be done by the Inspector of Artillery and a mechanic from the Royal Gun Factory to be present. The detachment of Royal Artillery for this service can be obtained by Colonel Tulloch's application to the Commandant.

The ammunition, &c. expended for this service by the batteries stationed at Woolwich is to be considered as part of their practice allowance, but not so with those which are stationed elsewhere.

(signed) *J. C. C.*
19/5.

(73—3—1022).

Royal Artillery Field Equipment.

Horse Guards, S. W.
Sir, 16 May 1860.

I AM directed by the General Commanding in Chief to acknowledge the letter dated War Office, the

the 8th inst. (73—3—963), and to state that the Commandant at Woolwich will be prepared to cause 20 rounds to be fired by the Royal Artillery from each Armstrong gun prior to its issue.

It is presumed by His Royal Highness that the ammunition for this service will be forthcoming from the department of the Inspector of Artillery, and I am to suggest that that officer be instructed to make the necessary arrangements with the Commandant from time to time for the attendance of parties of artillery at the practice ground.

I have, &c.
(signed) *Chas. Bingham,*
D. A. G.

The Under Secretary of State for War, War Office, Pall Mall.

(73—3—1080).

Military Store Office, Woolwich,
Sir, 11 June 1860.

A DIFFICULTY arises with respect to the carrying out of your order of the 19th May (73—3—1022 P.) relative to the final proof of Armstrong guns, as to whether such final proof should be under the orders of the Inspector of Artillery or Superintendent, Royal Gun Factories.

I have, therefore, the honour to request your orders on the following points:—At the final proof, last Wednesday, of the six guns prepared for issue to the 8th Battery, 8th Brigade, and which had been delivered over to me by the Royal Gun Factories (having been proved by the Superintendent with the usual cylinders), a large piece came out of the bore of one of the guns. I would wish to know what course I am to pursue in the matter, the gun in question being on my charge as serviceable, and yet not fit for issue. I conclude I may call upon the Superintendent, Royal Gun Factories, to exchange this gun, and which he is willing to do

The question, however, really is, whether the party first proving the guns should not finally prove them, otherwise there is a divided responsibility.

(signed) *H. W. Gordon,*
P. M. Storekeeper.

The Director of Stores, &c. &c.
War Office.

(73—3—1080.)

MINUTE PAPER.

ASK Inspector of Artillery and Superintendent, Royal Gun Factory, to report as to under whose superintendence this subsequent proof should be placed.

(signed) *H. D.*
14/6.

(73—3—A.G. 1097).

The Inspector of Artillery transmitting Letter relative to the Firing of 10 Rounds per Gun.

Inspector Artillery's Office,
Sir, 16 June 1860.

WITH reference to your letter of the 14th inst. (73—3—1080 P.), calling attention to your letter of the 19th ultimo (73—3—1012 P.), I have the honour to reply, that I conceive the arrangement made in the last-named letter to be under the circumstances the most advisable. It must be remembered that the proof rounds, as at present fired, give an opportunity of testing not only the gun but the carriage and the various fittings of both; and by reference to my Minute, dated 29th ultimo, it will be seen that I propose (and with regard to this part of my Minute I await the sanction of the Secretary of State) that the 10 rounds above referred to should also be made the means of testing the efficiency of the shell-bursters, time and concussion fuzes received from contractors, duties which belong to my department, and which can only be carried on under my inspection. App. No. 9.

I must also add, that the 10 rounds are fired by the Royal Artillery, and such being the case I conceive that the practice should be conducted by a military officer, with a competent artificer attending on the part of the Royal Gun Factories, as at present ordered.

I have, &c.
(signed) *Alex. T. Tulloh,* Col. R. A.,
Inspector of Artillery.

The Under Secretary of State for War,
War Office, Pall Mall.

(7—3—1110.)

Newcastle-on-Tyne, 16 June 1860.

The Under Secretary of State, War Office.
Sir,

REFERRING to your letter of the 14th June (No. 73—3—1080), it does not appear to me to be a matter of any importance who should have the superintendence of the final proof of the Armstrong guns made in the Royal Gun Factories, provided only some competent person be present to examine the guns after each round. The question is, how are the duties of the Inspector of Artillery to be defined? If they do not extend to any articles whatever manufactured in the Arsenal, there might perhaps be some inconsistency in assigning to him the superintendence of this final proof; but for my part I have no feeling on the subject, and would rather that the matter were decided without reference to me.

I have, &c.
(signed) *W. G. Armstrong.*

(73—3—1097.)

MINUTE PAPER.

Sir B. Hawes.

I CONCUR with Colonel Tulloh, and would submit that the arrangements be approved, and that these duties be carried out under his superintendence.

(signed) *J. C. C.*
19/6

Mr. Herbert,
Approve? Yes.

(signed) *B. H.* 19/6 (signed) *S. H.* 26/6

Inform Colonel Tulloh. Colonel St. George to see, and acquaint P. M. S. Woolwich.

(signed) *S. Wickens,*
for D. of S.
26/6

App. No. 9.

(73—3—1165).

MINUTE PAPER.

Director of Stores,

THE Armstrong gun equipments for a battery at Aldershot and one at Shorncliffe, are ready for delivery. The final proof of the guns will be delayed in consequence of the range at Plumstead Marshes not being available until after the hay-making season. In these circumstances the Deputy Adjutant, Royal Artillery, requests that the final proof of these guns may be carried out at the stations to which they are to be sent, the Assistant Inspector, Artillery, attending at the proof.

Submitted.

(signed) *T. Eaton.* (signed) *S. W.*

(10—7—60.)

Inspector of Artillery,
For opinion.

(signed) *J. C. C.*
11/7

I have made arrangements for the Assistant Inspector of Artillery to attend as requested.

(signed) *Alex. T. Tulloh*, Col. R. A.
Insp. of Artillery.

Inspector of Artillery Office.

12—7—60.

Sir B. Hawes,
For approval.

Approved.

(signed) *J. C. C.* 13/7 (signed) *B. H.* 13/7

War Office, 27 March 1863.

Alexander T. Tulloh, Major-General,
Director of Ordnance.

Appendix, No. 10.

RETURN of the Number of 12-Pounder ARMSTRONG GUNS made in the Royal Gun Factories, proved and passed; and of the Number Rejected by Major-General *Tulloh*, when Inspector of Artillery (between 8 December 1859 and 7 July 1861).

NATURE.	Marks of Identification.		Number Proved and Passed.	Number Rejected.	REMARKS.
	Factory Letters.	Factory Numbers.			
12-Pounder Guns (Land Service.)	R. G. F.	1 consecutively to 169.	150	19	—

LIST of the above 19 Rejected GUNS, showing the Dates when any of them, having been Repaired, were passed into the Service.

NATURE.	Marks of Identification.		Date Passed.	NATURE.	Marks of Identification.		Date Passed.
	Letters.	Numbers.			Letters.	Numbers.	
12-pounder guns (land service).	R. G. F.	5	11 Dec. 1860	12-pounder guns (land service).	R. G. F.	75	7 Dec. 1860
	,,	15	7 Dec. –		,,	76	
	,,	21	13 June –		,,	96	
	,,	31	25 Jan. 1861		,,	97	
	,,	42	7 Dec. 1860		,,	102	
	,,	49			,,	121	
	,,	52			,,	137	
	,,	57			,,	144	
	,,	73			,,	161	
	,,	74					

The above 12-pounders were all lined except Nos. 21 and 74, and passed into the Service by the Superintendent Royal Gun Factories.

Alex. T. Tulloh, Major-General,
Director of Ordnance.

Office of Inspector of Artillery,
26th March 1863.

Appendix, No. 11.

ARMSTRONG'S GUNS—OLD BREECH-LOADING (SCREW).

App. No. 11.

ORDNANCE SELECT COMMITTEE.

(Committee Minute, No. 6362.—Report, No. 2223, 4th April 1862.)

SUBJECT:—1671 G.—Armstrong's 100-pounder Gun. 5364.

I. Gun-metal lining for guns having inner barrels made of solid iron.
II. Coiled tube for ditto.

W. O., 12/11/61. With reference to Report 1903, Minute 5131, transmits a return furnished by R. G. F., showing the total number of guns made with inner barrels of solid iron. 80—A.—1253 (A).

Total 264
Deduct 5 (Nos. 3, 204, 207, 228, and 196), refitted with coil tubes.

259

Directs the Committee to make a trial of a 100-pounder subsequently lined with a coil tube.

COMMITTEE'S REPORT.

The Committee have the honour to report that, pursuant to the instructions of the Secretary of State, 110-pounder, No. 214, has been submitted to the test of firing 40 rounds of the usual proof series from one shot up to cylinders equal to four shots with the service charge, and is entirely uninjured, excepting an indentation about 0·025 inch deep, and $5\frac{1}{4}$ inches wide, commencing at $18\frac{1}{4}$ inches from the end of the breech.

10 rounds 1 shot.
10 „ 2 „
10 „ 3 „
10 „ 4 „

This gun is of the service or strengthened form, but was selected for experiment, as representing a class of guns originally made on an inner tube bored from a solid forging, but which has since been removed, and another inner tube made from a coil substituted. The Committee consider the result to prove that such guns, when well made, are perfectly fit for the service. One vent piece was used throughout the experiment, and is uninjured.

(signed) *J. St. George*,
President, O. S. C.

ORDNANCE SELECT COMMITTEE.

(Committee Minute, No. 6401.—Report, No. 2236, 9th April 1862.)

SUBJECT:—1671 G.—Armstrong's 100-pounder B. L. Gun. 4739.
Reduced charge for guns of original construction.

W. O., 24/8/61. Informs the Committee, that it is the wish of the S. of S. that the unstrengthened 100-pounder Armstrong gun for trial, be not fired with the service shells or charge, but with lighter shells (of which it appears there are a large number in store), and a reduced charge of 11 lbs. 73—3—2188.

The experiments to be made as soon as practicable.

COMMITTEE'S REPORT.

The Committee have the honour to report that they have fired the following number of round-bottomed 110-pounder shells of original pattern, of which there were 9,314 in store on 5 October 1861: Min. 5074.

45 Min. 5,823, unaltered shells from a 110-pounder, charge 10 lbs.
10 Min. 6,401, shells reloaded, the lead attached by zinc solder, charge 10 lbs.
1 - - - - 12 lbs.
1 - - - - from a 7-inch howitzer, charge 9 lbs.

57

App. No. 11.

The reason that no second shell was fired in the two last classes was, that the turning over of the first showed that the conclusion drawn from the other 55 shells fired with 10 lbs., must be extended to shells fired with either higher or lower charges. Of the 45 unaltered shells, 11 turned over in flight, and 12 others were very unsteady. Of the 10 re-leaded shells, six turned over, and three others were very unsteady. It is evident, therefore, that the round bottomed 110-pounder shells in store are, at present unserviceable, even for practice at short ranges, as they exhibited great irregularities within 1,000 yards.

The Committee are unable at present to assign any sufficient cause for this effect. It was at first supposed that the thin sheet copper of Boxer's Lubricator, might possibly be doubled up round the bottom, or be forced into the grooves; but of five rounds fired at 5° without it, two turned over in flight, and two others were unsteady to a degree quite unknown to the service pattern. It is now proposed to fire 30 shells releaded with a higher gauge; the marks of rifling have been very much less clear than usual, although the gauge of the shells is the same as that of the service pattern shells, and the Committee will report the result as soon as possible.

(signed) *J. St. George*,
President, O. S. C.

ORDNANCE SELECT COMMITTEE.

(Committee Minute, No. 6480.—Report, No. 2255, 28th April 1862.)

SUBJECT:—1671 G. p.—Armstrong's 110-pounder B. L. Gun.

6316.

Failure of guns in proof of vent pieces.

61—Inspector of Artillery—238.

W. O. by Minute 22/3/62. Forwards for immediate consideration:—(1.) Letter from P. S. of Stores 12/3/62, reporting that three 110-pounders have been rendered unserviceable within the last few days in proving vent pieces; and requesting instructions as to the issue of another gun for this service.

Another gun has been ordered to be issued.

(2.) Report from Inspector of Artillery, 19/362, on this subject. He states that a number of guns have been used from time to time in this service. In October 1861, No. 28 E. O. C., after being tested for endurance (Minute 4978), was specially selected, since which it has fired in proving vent pieces, 155 rounds, with charges of 27½ lbs. and solid shot. During this practice an opening appeared between the trunnion hoop and the coil in rear of it; and although no defect was observable in the interior, as it gradually increased the gun was ordered for examination. Two other 110-pounders were then selected:—No. 143 E. O. C., and No. 191 E. O. C.; the first because it had been repaired with new breech and strengthening coils in the R. G. F.; the second, because it had been lined throughout. No. 143 fired 20, and No. 191 50 rounds, with charges of 27½ lbs., when both exhibited such appearances of giving way, that it was not considered advisable to continue using them.

No. 17, R. G. F., a gun having the inner barrel made of solid forging, was then selected, as from the manner of failure of the other guns, greater longitudinal strength appeared desirable. It was, however, rendered unserviceable after 42 rounds.

The proof of 110-pounder vent pieces is now suspended, except in the case of those proved with the guns to which they belong.

Three of the guns show a separation on the outside between the trunnion ring and the coil behind it; this separation is at the top of the gun, and not at the bottom, and the guns are bent; the fourth gun (No. 191) shows the separation all round, but to less extent than the others. All the guns have expanded in the shot chamber and part of the powder chamber, and the bores have become elongated. The expansion is greatest just at the base of the shot, and varies in depth from 0·115 inch in No. 28, to 0·212 inch in No. 191. It extends back into the powder chamber, gradually tapering off. The appearance of the guns indicates a pressure at the seat of and behind the shot greater than the strength of the material used could resist, and the Inspector of Artillery is of opinion that similar injuries will be produced when any gun is used with the present proof charges. An excessive strain is evidently exerted on a part of the bore by the large charge used, and this exceptional effect may be due to a forward movement of powder and gas being suddenly checked by the resistance of the shot. The effect produced seems to be only the aggregation of a number of the indentations so frequently complained of in the ordinary proof.

None of the guns used in proving vent pieces previous to the increase of charge from 25 to 27½ lbs. failed.

The gradual failure of these guns under such very trying conditions, and general experience of the Armstrong system of construction, warrant the belief that no accident is likely to arise from guns bursting, but that sufficient warning of a failure will always be given.

He

He recommends the reconsideration of the present proof charges, at least as regards the heavy natures of guns; and suggests that in proving spare breech screws and vent pieces, the charge be diminished and the number of rounds increased. App. No 11.

Committee's Report.

The Committee have the honour to report that there is nothing in the facts referred for their consideration which leads them to conclude that the present proof charge for the 110-pounder, viz., 27½ lbs. of powder is too great. It appears that three guns employed in the proof of vent pieces, have shown symptoms of failure with a comparatively small number of rounds, viz.:—

No. 143 with 20 rounds.

No. 17 with 42 rounds.

No. 191 with 50 rounds.

But no one of these guns was entirely conformed to the sealed pattern.

No. 143, made by E. O. Company, had received a new breech and strengthening coil in the Royal Gun Factories. No. 17 was a gun with the centre bored out of a solid tube. No. 191 was a gun which had been lined throughout.

On the other hand, three guns are quoted which have stood from 50 to 155 rounds, and two which have stood respectively 50 and 102 rounds of 25 lbs. charge without injury. Rounds of 27½ lbs. No. 28, 155 in addition to other very severe tests. No. 205, 80. No. 215, 70.

The only inference therefore which the Committee feel warranted in drawing is, that guns which have undergone repairs in consequence of a first failure, and have been proved a second time, are inferior in strength to the unaltered service pattern, and although strong enough for all practical purposes with service charges, are not fit to be taken for these severe trials.

For this reason, the Committee recommend that the gun next taken to prove vent pieces be one of the best that can be selected, and a careful record kept of the effects of the service upon it; but they do not recommend a reduction of charge.

(signed) *J. St. George*,
President, O. S. C.

Ordnance Select Committee.

(Committee Minute, No. 7175.—Report No. 2437, 27th August 1862.)

Subject:—1671 B.—Armstrong's 12-pounder gun of 8½ cwt. 6887.

Test as to general efficiency by firing from 12 guns, 100 rounds each consecutively.

W. O. by Minute 21/6/62. Forwards for Committee to see, a letter from Colonel Cuppage, commanding Royal Artillery, S.E. district, covering Colonel Ormsby's report of the practice carried on at Hythe on the 24th April 1862, with 12 12-pounder Armstrong guns, by firing 100 rounds from each gun as rapidly as if actually engaged with an enemy. Minute 5307. 73—3—3005.

The guns used in this practice were Nos. 63, *68, 77, 90, 93, *160, *181, 199, *259, *270, *280, *315.

*Had flaws in them prior to issue. No. 160 gun is the only one which appears to have been injuriously affected by the firing, a previously existing flaw having been a good deal enlarged.

The practice was extremely good. None of the vent pieces were blown out. None of the guns disabled.

Committee's Report.

In returning the accompanying papers relative to the experiment made at Hythe in April last, by firing 12 Armstrong 12-pounders, 100 rounds each continuously, the Committee think it necessary to observe that Colonel Ormsby's letter of 9th August, does not remove the impression that sponging became necessary, or was so considered by some of the officers, notwithstanding the employment of Boxer's lubricators; as Colonel Ormsby only

App. No. 11.

speaks of the guns "slightly fouling," it is possible that the necessity may not have been a real one: but as the question whether or not sponges shall continue to be issued for land or sea service, turns entirely on the efficiency of lubricators for the longest continuance of fire that can occur on conditions of service, the Committee consider it necessary that a fresh experiment should be made, and they request authority to fire 100 rounds from the 12-pounder gun, which showed the first signs of requiring sponging on the occasion to which Colonel Ormsby refers. If approved, they request that instructions be forwarded to the officer commanding south-eastern district, to forward the gun in question to the principal superintendent of stores at Woolwich, for the Committee's experiment.

(signed) *J. St. George*, President, O. S. C.

ORDNANCE SELECT COMMITTEE.

(Committee Minute, No. 5962.—Report, No. 2115, 31st January 1862.)

5901.

SUBJECT:—1671 A.—Armstrong's 9-pounder gun of 6 cwt., for R. H. A.

73—3—2625. 5792.

W. O. paper, 21/1/62. D. of O. asks the reason why the 9-pounder horse artillery gun is not ready to be reported upon.

COMMITTEE'S REPORT.

The Committee have the honour to enclose an abstract of practice with 9-pounder gun of 6 cwt. (new pattern), and to inform the Secretary of State that having witnessed the firing of a further number of 115 rounds from this gun on the 27th and 28th instant, they are of opinion that the gun itself may be approved, but that an alteration is required in the sights, and in the elevating screw handles, which will occasion a little delay before the equipment can be sealed.

2. An alteration is also required in the new pattern concussion fuze C, before the proposed ammunition can be pronounced complete and ready for service.

3. It will be seen that the practice with plugged shells was extremely regular, although not equal in point of uniformity to that of the 12-pounder, and the ranges for equal elevations are about 1-10th less. In proceeding, however, on the 27th and 28th instant to fire live shells with the new pattern concussion fuze C, the results were less satisfactory. Of 10 shells fired with time fuzes (old pattern) and concussion fuze C, two burst prematurely. Of 105 shells fired with concussion fuze C alone, nine burst prematurely, and one of these at the muzzle. It is evident, therefore, that the new concussion fuze C, on which the efficiency of the shell depends, stands in need of further improvement. Sir William Armstrong expresses himself confident of being able to overcome the defect, but in the meantime nothing more than the gun itself is to be considered ready for sealing.

4. The new pattern sight was found inconvenient, and will require further alteration.

5. The handles of the elevating screw are rather too long for convenience in elevating, and when the gun is at a considerable elevation they interfere with the tappet handle; this can be remedied at once.

P.S. It has been remedied by reducing the length of the handles.

6. A detachment of R. H. Artillery, under Lieutenant Waddington, having been sent to Shoeburyness for the purpose, the Committee, on the 28th instant, witnessed the firing of 80 rounds against time; targets 27 × 9 feet, were erected at 800, 1,200 1,600, and 2,000 yards. The cartridges were made up with Boxer's lubricator, the gun was not sponged for the 80 rounds. The first 40 rounds were fired in 31 minutes, the gun being laid alternately at the 800 and 1,200 yards targets, with elevations 1° 45 and 2° 55 respectively. Average time 0·46⅔ seconds.

The next 40 rounds were fired in 38 minutes, the gun being laid alternately at the 1,600 and 2,000 yards targets, with elevations 4° and 6° respectively. Average time 0·57 seconds.

The laying was careful, and not at all hurried. At the conclusion the gun was not overheated, but the vent-piece and screw worked stiffly; the copper ring on the former was much worn, and the mouth of priming chamber also considerably cut. The same vent-piece was used throughout. The gun copper did not appear to have suffered, but a more minute examination of its condition will be made when the gun returns to Woolwich.

7. With respect of the precision of this rapid firing; it was extremely satisfactory at 800, 1,200, and 1,600 yards; but the whole of the shells went over at 2,000 yards, owing to too great an elevation (6°) being given. One of the three 9 feet targets at 800 yards was knocked down the 4th round, another the 16th round; there were therefore only two targets up from the 6th to the 16th, and only one from the 17th to the 20th round.

The

The final result of 20 rounds was—

Shell.			*Segments.*		
Lodged.	Struck.	Through.	Lodged.	Struck.	Through.
1	62	93	2	7	72

15 Fuzes through and lodged.
6 Bottoms through.
2 Bursters through.
6 Shells through before bursting.
41 Pieces of lead lodged.

One of the three 9-feet targets, at 1,200 yards, was knocked down the fourth round, another the ninth round; there were therefore only two targets from the fifth to the ninth round, and only one from the 10th to the 20th round.

The final result of 20 rounds was—

Shell.			*Segments.*		
Lodged.	Struck.	Through.	Lodged.	Struck.	Through.
10	32	65	14	7	95

48 Pieces of lead lodged.
4 Shells through before bursting.
7 Fuzes lodged.
5 Bottoms through.
5 Bursters through.

The three targets, at 1,600 yards, stood to the end of 20 rounds, and the final result was—

Shell.			*Segments.*		
Struck.	Lodged.	Through.	Struck.	Lodged.	Through.
23	5	31	5	28	23

19 Pieces of lead lodged.
4 Shells through before bursting.
3 Fuzes lodged.
1 Bottom through.
1 Bottom lodged.
3 Bursters through.

(signed) *J. St. George,*
President, O. S. C.

1671 A–3.—Armstrong's 9-pounder Gun of 6 cwt. for R. H. A.
Minute 5036.
Trial of Travelling Carriage.

5792.

With reference to Minute 5319. Secretary submits an Abstract of Practice with 9-pounder Horse Artillery Gun.

Gun No. 2.—Weight, 6 cwts. 0 qrs. 14 lbs; length, 5 feet 2 inches; calibre, 3 inches; twist, 1 turn in 38 calibres; No. of grooves, 38.
Height of Gun above plane, 3½ feet.

Segment Shells (Plugged).

DATE.	No. of Rounds.	Elevation.	Mean reduced time of Flight.	RANGES.			Mean difference of Range.	Mean observed Deflect.	Mean reduced Deflect.	REMARKS.
				Min.	Max.	Mean.				
1862:			*Sec.*	*Yds.*	*Yds.*	*Yds.*	*Feet.*	*Feet.*	*Feet.*	
Jan. 4th -	20	2°	3·04	847	964	919·8	19·7	5·8	2·3	Wind blowing across range.
Wind 4–5	20	5°	6·14	1,786	1,864	1,821·1	20·2	32·2	4·7	
	20*	10°	11·00	2,927	3,051	2,980	26·0	122·1	10·1	* Mean of 19 rounds.

Elevation by tangent. The gun was perfectly lubricated with Boxer's lubricators. No sponge was used.

At about 6°—the horns of the elevating screw-jam with the balls of the lever.

The tangent scale, if taken out to arrange and clamped, is liable to alter when dropped into its place again. The mill-headed screw for deflection is not large enough: the head of the scale carrying the sight interferes with the mill-headed screw of the deflection scale when moved much to right or left.

The carriage worked well, as far as could be judged—firing on the level.

Appendix, No. 12.

ARMSTRONG 40-POUNDER AND 70-POUNDER GUNS.—SIDE BREECH-LOADING.

App. No. 12.

ORDNANCE SELECT COMMITTEE.

(Committee Minute, No. 5769 (10/1/62).—Report, No. 2086, 13th January 1862.)

5595. SUBJECT:—1671 I.—Armstrong's 70-pounder Gun, with New Side Breech-loading arrangement.

Minute 5232.

73—3—2440. W. O. 11/12/61. With reference to Report 1951, Minute 5332, sanctions experiments being made with this gun to the extent the Committee may think necessary.

Adds, that 50 shots and 50 common shells have been ordered to be supplied from Elswick.

COMMITTEE'S REPORT.

The Committee have carried on experiments to test the efficiency of the 70-pounder gun with new side breech-loading arrangement.

From the enclosed abstract of practice it will be seen that the results were unsatisfactory; the variation of range with this gun being greater than with Armstrong guns of other natures.

Sir William Armstrong has stated, that before the Committee proceed to carry out a more extended trial of this gun, it will be necessary for him to make some departmental experiments with a view to improving the projectile; to this there appears no objection.

The Committee, however, beg to state, that in consequence of the calibre of this gun being so large in proportion to the weight of the projectile, it will, in their opinion, be impracticable to obtain an efficient solid shot for a gun of this description.

The Committee recommend, that if any supply of these guns be immediately contemplated, they should be constructed on the principle of breech-loading adopted in the service, as their experience with the new breech-loading arrangement has not been sufficient to enable them to judge of its efficiency.

(signed) *J. St. George*,
President O. S. C.

MINUTE 5746.

1671 I.—Armstrong's 70-Pounder B. L. Gun (Experimental No. 161), with the New Side Breech-loading arrangement.

Minute 5232.

I. Secretary submits an Abstract of the Practice with Common Shells, in continuation of Minute 5725.

Height of gun above plane, 20 feet.
Shells, filled, 75 lbs.; charge, 9·0 lbs.; burster, 5 lbs.

DATE.	No. of Rounds.	Elevation.	Mean reduced time of Flight.	RANGES. Min.	Max.	Mean.	Mean difference of Range.	Mean observed Deflect.	Mean reduced Deflect.	REMARKS.
1862:			*Sec.*	*Yds.*	*Yds.*	*Yds.*	*Yds.*	*Yds.*	*Yds.*	
Jan. 3d -	10	2°	3·50	1,104	1,259	1,168	39·1	1·88	0·71	1 rejected.
Wind 3–4	10	5°	6·95	2,144	2,255	2,193	23·9	4·30	2·10	
	10	10°	12·38	3,547	3,729	3,594	68·5	22·32	3·60	

Elevation by quadrant.
Tin cup, No. 19 gauge. Boxer's lubricators.
The B. L. arrangement worked well, with no escape of gas.

App. No. 12.

Ordnance Select Committee.

(Committee Minute, No. 7388.—Report, No. 2460, 22d September 1862.)

7388.

Subject:—1671 I.—Armstrong's 70-pounder side B. L. Polygrooved Gun, experimental, No. 178.

Minute 6675.

73—3—3272.

W. O. 15/9/62. Notifies that the Secretary of State desires that the Committee will use every effort to complete the experiments with the 70-pounder guns, and make their report as soon as possible, it being of the greatest importance that an early decision should be come to on the pattern to be adopted for this nature of gun.

A report is to be made at once showing the progress that is being made, and the probable date when the final report may be expected.

See Minute 7174. The Committee are waiting for the new polygrooved gun promised by Sir W. Armstrong: 25 each of shot and shell for this gun were demanded 25/8/62, but have not yet been supplied.

Committee's Report.

The Committee have the honour to report, that the delay in coming to a decision in respect to the pattern to be adopted for the 70-pounder Armstrong guns has been occasioned by circumstances over which they have had no control, and which are due solely to the improvements and alterations which Sir William Armstrong has from time to time considered desirable to introduce to meet such defects as were developed in the trials to which the 70-pounder guns of this description have been subjected. In reporting upon the progress that has been made in experiments with Armstrong 70-pounder guns with side breech-loading arrangement, the Committee beg to refer to their Report, No. 2086, Minute 5769, 13/1/62, on the 70-pounder breech-loading gun, experimental, No. 161, which was tried at Shoeburyness 3/1/62, with unsatisfactory results. Subsequently the Committee were informed by W. O., 11/1/62, 75—12—1263, that in compliance with Sir W. Armstrong's request, directions had been given to the E. O. Company to supply him with projectiles of such kind as he might require for preliminary experiments with his 70-pounder gun. On the 23d May 1862, the Committee were instructed by W. O., 73—3—3038, to demand and report upon a 70-pounder side breech-loading gun supplied by Elswick Ordnance Company, to govern the supply of 100 guns for sea service. This gun, experimental No. 178, differed from that tried in January in the following respects:—

1. Thickness of metal behind wedge block, increased from 8·5 to 11 inches.
2. Length, 4 inches shorter.
3. Pitch of rifling diminished from 1 in 41 to 1 in 55 diameters.
4. Grooving of the same form as 110-pounder gun.
5. Slide covering vent arranged to lock both handle and block.

This gun was tried at Shoeburyness on the 5th August, with the following results:—Out of 78 rounds fired, 9 were unsteady in flight.

It appeared, also, to the Committee to be a question for consideration whether the gun had not too slow a twist; and whether the bearing surfaces of the wedge might not be somewhat reduced by grooves, and the friction diminished, without taking anything away from the resistance.

The breech-loading arrangement, however, worked well on the whole.

These results were duly communicated to Sir William Armstrong; and at a subsequent interview which he had with the Committee (on the 20th August), it was agreed that the alterations and improvements above suggested should be introduced in a new gun which was to be ready in a fortnight.

The Committee have not yet received this gun, nor the stores demanded for its trial; they have sent a reminder to Sir William Armstrong on the subject, and as soon as the gun and stores are delivered, they will make every effort to complete the experiments, and finish their report with as little delay as possible.

(signed) *J. St. George,*
President, O. S. C.

App. No. 12.

Ordnance Select Committee.

(Committee Minute, No. 7599.—Report, No. 2506, 17th October 1862.)

Subject:—1671 I.—Armstrong's side Breech-loading arrangement, 40-pounder.

With reference to W. O. Letter dated 29/3/62 (57—2—6368); and telegram, 6/5/62.

70-pounder.

W. O. Letter 15/9/62 (73—3—3272); and Committee's Report, No. 2460, 22/9/62.

Committee's Report.

The Committee have the honour to report that on the 13th instant they witnessed the firing of—

1. Polygrooved 70-pounder (Experimental, No. 185), with side breech-loading arrangement.

2. Naval 40-pounder (Experimental, No. 184), with side breech-loading arrangement; with the special object, in both cases, of again testing this system of breech-loading in rapid firing, with all the improvements introduced since it was first proposed. Only secondary regard was paid to range and precision, to which full justice cannot be done under those circumstances.

The 70-pounder fired 50 rounds in 32 minutes 32 seconds.

The 40-pounder fired 50 rounds in 31 minutes 4 seconds; both guns were laid properly for every round—25 at 5°, 25 at 10°. Not the slightest difficulty occurred from any defect of the breech-loading arrangements. Some slight delays occurred in each series, from other causes, amounting to one or two minutes; but these are included in the above totals.

The breech worked easily; there was no escape of gas; no oil was employed during the firing: the guns were not sponged. The men had had very little previous exercise with the guns.

2. The Committee are well aware of the great importance of an early settlement of the question whether or not the side breech-loading, or wedge system shall be introduced into the service; they will therefore state, as briefly as possible, how the question now stands.

Min. 3629. 80—A—1030. Min. 4282. Min. 5256.

The Committee first heard of this system of breech-loading in March 1861. The first gun so prepared, a 110-pounder, rifled on the 3-grooved shunt system (E. O. C., No. 20), was not reported ready for their trial until October, but was sent to Shoeburyness for private trial in May. It exhibited some weakness in proof, which induced Sir William Armstrong to alter certain dimensions, and to request that no final opinion of the merits of the system should be based on that gun; but the Committee, on 1st November, witnessed the firing of 50 rounds, on a common proof sliding truck, at a rate, deducting delays, of 50 rounds in 20 minutes 55 seconds. The delays deducted had nothing to do with the gun. The longest strictly consecutive series was 15 rounds in 6 minutes 10 seconds.

Report, No. 1942. 11/11/61.

The Committee reported that they were favourably impressed with the system, but not yet in a condition to recommend its introduction. Since that date they have tried five other side-breech loading guns:—

No. 161, 70-pounder	44 grooves	rifling 1 in 41	calibre,	Min. 5,332
No. 178, 70-pounder	70 „	1 in 55	„	6,808
No. 185, 70-pounder	- „	1 in 45	„	7,174
No. 146, 40-pounder, short	„	1 in 45	„	4,597
No. 184, 40-pounder	56 „	1 in 36·5	„	7,411

making six guns in all; the two guns now under report have received all the improvements and modifications suggested by the trials of the other four; and with the exception of a trifling alteration in the set of the 40-pounder handles, do not appear to require any further improvement.

The Committee, however, are bound to point out that some of the above guns have been very little fired, and that none of them have received that varied and prolonged trial which should be given to them before so important a change as the adoption of a totally different system of breech-loading from that now in use, can be safely recommended.

It

It appears that they have fired in all the following rounds, independent of any that may have been fired in private trials, of which the Committee have no record: — App. No. 12.

	By Committee.		By
	For Rapidity.	For Precision.	Sir W. Armstrong.
No. 20, 110-pounders - - - -	50	0	0
No. 161, 70 „ - - - - -	0	30	76
No. 178, 70 „ - - - - -	0	79	not known.
No. 185, 70 „ - - - - -	50	0	„
No. 146, 40 „ - - - - -	0	4	„
No. 184, 40 „ - - - - -	50	100	none.
Total - - -	150	213	76

The Committee now recommend that 70-pounder No. 185, and 40-pounder No. 184, be sent immediately to Captain Hewlett, for a full trial on board Her Majesty's ship "Excellent," and they feel warranted in recommending that—

4 70-pounders, with land-service fittings,
16 70-pounders, with sea „
4 40-pounders, with land „
16 40-pounders, with sea „

be completed at once, and issued according to the following distribution:—

	70-Pounders.		40-Pounders.	
	Land Service.	Sea Service.	Land Service.	Sea Service.
Shoeburyness - - - - -	2	- -	2	—
Royal Artillery - - - -	2	- -	2	—
H. M. S. "Excellent" - - -	- -	4	- -	4
„ "Cambridge" - - -	- -	4	- -	4
Royal Marine Artillery - -	- -	2	- -	2
H. M. Ships on home stations - -	- -	6	- -	6

For one gun of each nature on board the "Excellent" and "Cambridge," the Committee recommend 300 rounds of ammunition to be issued, and for each of the others, 300 rounds. A very minute record should be kept, and full report made of the working of the system in all particulars. In the meantime they have demanded one common naval 40-pounder broadside carriage, and one naval 70-pounder broadside carriage for Nos. 184 and 185 respectively, and these guns should be sent to the "Excellent" as soon as possible. Should the other 20 40-pounders and 20 70-pounders be ordered as above recommended, the Committee would suggest the preparation of broadside carriages for them at the same time, with the full proportion of tin cups, lubricators, and other stores.

With respect to the performance of these guns:—

The 70-pounder was fired on the last occasion with the tide in. No 161 was fired 30 rounds in January last by the Committee, and did not make very good practice, which was attributed to the slow twist of the rifling, and the form of the projectile, both of which have been altered for No. 185. Min. 5476.

The Committee will report the practice with this gun as soon as completed; it appears satisfactory.

The 40-pounder made excellent practice on the 13th instant, giving at—

	Mean Range.	Mean Difference of Range.
	Yards.	*Yards.*
Five degrees - - - -	2,147	25·0
Ten degrees - - - -	3,688	45·3

These ranges do not differ sensibly from those of the standard or land service 40-pounder, and if hereafter confirmed, will show that there is little or nothing gained by the additional

App. No. 12.

21 inches length of the latter, which also the former practice with a shortened gun (Min. 2346) tended to show. The means for the land service 40-pounder may be taken to be—

	Range.	Difference of Range.
	Yards.	*Yards.*
For five degrees - - -	2,150	26·5
„ Ten degrees - - -	3,660	25·0

(signed) *J. St. George,*
President O. S C.

ORDNANCE SELECT COMMITTEE.

(Committee Minute, No. 6145-6180.—Report, No. 2187, 4th March 1862.)

6180.

SUBJECT:—1671 D.—Armstrong's Naval 40-pounder Gun with side B. L. arrangement. Pattern II. A.

57—7—6223.

W. O., 28/2/62. Informs the Committee, that it has been proposed by Sir W. Armstrong, that the Assistant Superintendent of the R. G. F. should be instructed to complete one of those guns already ordered to be proceeded with, in accordance with a plan which he (Sir W. A.) will furnish, and which he believes will be free from the objections which the Committee entertain to the pattern gun now before them.

6145.

The Committee are requested to report whether they concur in this proposal.

COMMITTEE'S REPORT.

The Committee have the honour to report, that on proceeding to Shoeburyness on the 20th February, to try the 40-pounder wedge gun, they found that it had an imperfection which Sir W. Armstrong proposes to remove in any future guns on this principle, but which he is not sure that he can remove from the present gun. It is, that the tappet handle, by which the supporting wedge is tightened and loosened, starts at every discharge, conveying the idea of insecurity, and perhaps with some actual risk of its fracture.

The Committee think it of such importance that the gun which represents the system should represent it perfectly, that they are unwilling to proceed with the trial until it can be put into their hands in all respects what the future service gun is proposed to be; and they think it right to add that, in their opinion, the change of system cannot be prudently introduced for broadside 40-pounders upon the testimony of a single gun; at least six guns should be made on this model, and tried on board H. M. ships "Excellent" and "Cambridge," as well as at Shoeburyness, before its adoption.

The Committee, however, think it desirable that the one complete gun referred to in W. O. letter (57—2—6223), 28/2/62, received since this Report was agreed to, should be produced and tried before making so many as six for trial.

(signed) *J. St. George,*
President, O. S. C.

Appendix, No. 13.

ARMSTRONG'S GUNS.—MUZZLE LOADING.

App. No. 13.

ORDNANCE SELECT COMMITTEE.

(Committee Minute, No. 6375.—Report, No. 2224, 4th April 1862.)

SUBJECT:—2238.—Muzzle-loading smooth-bore wrought-iron 300-pounder gun, constructed on Sir William Armstrong's principle; (10-48 calibre, 150-pounder.) 5637.

W. O., 17. 12. 61. With reference to Minutes 5298-5436, notifies that directions have been given for the supply of 200 spherical shot for this gun. 80—A—1264.

COMMITTEE'S REPORT.

The Committee have the honour to report for the information of the Secretary of State, that they have ascertained the following particulars respecting the qualities of the smooth-bored 150-pounder of 12 tons, which has been placed in their hands for experiment prior to its conversion into a rifled 300-pounder.

(1.) The weight of the gun and carriage does not prevent its being worked without difficulty on a traversing platform by 10 men. The weights are, 150-pounder M. L. Gun,

Tons.	*cwt.*	*qrs.*	*lbs.*	
11	19	0	22	Sliding carriage, including compressors.
1	18	2	14	

(2.) The shot has an initial velocity of 1,720 feet, with a charge of 40 lbs. of L. G. Powder. It has not yet been ascertained what the velocity will be if the very large grain 2 A 4 powder is used.

(3.) It has a range of about one-fifth greater than that of the 68-pounder with 16 lbs. charge, combined with considerable precision for a smooth-bored gun.

At 5 degrees, mean range	2,417 yards.
At 10 „ „	3,473 „

The ranges appear to be very nearly the same as those of the 13 Mersey gun. This latter, however, used a smaller relative charge in the ratio of 18 to 26, and its excess of relative range must be attributed to its having only half as much windage and greater weight of shot in reference to the area of resistance. Windage in terms of the whole area of the bore:

Service 68-pounder	0·053
„ 150 „	0·024
„ 280 „ (Mersey)	0·012

The Mersey Gun (13 inch) is also 0·4 calibre longer than the 150-pounder, their length of bore being respectively 12·3 and 11·9 calibres.

(4.) Fired from a height of 19 feet, at an elevation of one-half degree, the shot ricochetted on water to a distance of about 2,500 yards with considerable regularity, in bounds of 500 or 600 yards each.

The Committee submit the foregoing conclusions to the Secretary of State, circumstances having given a great degree of interest at the present moment to the consideration of the powers possessed by heavy artillery. Taking velocity and weight together, the 150-pounder will strike a blow equal to that of 2½ 68-pounder shot, or rather more, and the Committee regard it as a matter of much interest to determine what the effect of such a blow will be upon the strongest iron-plating. They therefore request permission to fire it, or that it be fired by the Special Committee on iron plates, against one of the iron targets at Shoeburyness.

(signed) *J. St. George,*
President, O. S. C.

App. No. 13.

Ordnance Select Committee.

(Committee Minute, No. 6980, 18/7/62.—Report, No. 2385, 21st July 1862.)

6662. Subject:—2022.—Wrought-iron muzzle-loading guns, as proposed by Sir W. Armstrong, Minute 2936, 120-pounder grooved, shunt.

80—G.N.—475. W. O. 23. 5. 62. Notifies approval of the 120-pounder M. L. shunt gun being fired with 25 lbs. of powder, and shot weighing 100 lbs., to ascertain initial velocity, as proposed in Report 2271, Minute 6533½, and also sanction of the expenditure of the sum of 35 *l.* for this experiment.

D. of O. informs the Committee that Sir W. Armstrong has suggested that the shot should have brass or copper strips, instead of zinc, inserted as ribs to take the rifling.

Committee's Report.

The Committee have the honour to report, for the information of the Secretary of State, that the 120-pounder muzzle-loading shunt gun, which they were authorised to fire with shot reduced to 100 lbs. weight, and a charge of one-fourth, gave way in the trunnion coil at the second round, and is at present unserviceable. The actual weight of the shot fired was only 98 lbs., and the charge 24½ lbs. The gun having been fired with impunity by the Iron Plate Committee with shot of 140 lbs. and a charge of 20 lbs., this accident cannot be attributed to the severity of the charge. It has fired altogether 103 rounds, and the present failure must either be traceable to a weakness originally stated by Sir William Armstrong to exist in it, or be the consequence of using the powder known as 2 A 4: The Committee do not apprehend the latter to be the case, and the reported position of the crack, which is far forward, tends to show that a flaw must have existed, because the force of the powder would be diminished by expansion to less than one-half of its original amount before it could operate on that part of the structure. The gun will be at once examined.

Min. 5317.

(signed) *J. St. George,*
President, O. S. C.

Ordnance Select Committee.

(Committee Minute, No. 8355, 4/2/63.—Report, No. 2681, 6 February 1863.)

Subject:—Armstrong's 70-pounder wrought-iron M. L. 6-grooved shunt gun, Expl., No. 180.

8355. 73—3—3534. II. W. O. by Minute 2. 2. 63. Referring to a question put by P. S. of Stores, as to whether payment should be made for this gun, notifies that it is important that it should be included in the Estimates for the present financial year; and that much depends upon the Committee's report, for which the W. O. are waiting.

See Minutes 6951–8294.

Committee's Report.

The Committee have the honour to report that the muzzle-loading 6-grooved shunt-rifled gun, No. 180, which they received orders to try in July 1862, had fired, altogether, to the 31st December, 185 rounds, and is perfectly serviceable. It is a gun of considerable precision, but has never, in their experiments, come up to the extraordinary results obtained by Sir William Armstrong in some preliminary practice on 23d June 1862. The annexed abstract includes the results of 119 rounds. They are inferior in general precision to the service 110-pounder, giving, on the average of all the observations with service powder, the following data:—

Elevation.	Mean difference of range. *Yards.*	Mean deflection. *Yards.*
2 degrees	37·97	0·95
5 „	40·92	2·50
10 „	60·0	3·15

Whereas the 110-pounder, upon the average of 382 rounds, fired on many different occasions, gives—

Elevation.	Mean difference of range. *Yards.*	Mean deflection. *Yards.*
2 degrees	18·33	0·67
5 „	32·96	1·79
10 „	61·48	4·18.

It

It appears to be also inferior to the 70-pounder wedge breech-loading guns, but a decided opinion can scarcely be expressed on this point without more experience of both guns. It is to be remembered, however, that Sir William Armstrong's results of 23d June 1862, were produced with 2 A 4 powder, and that on repeating the practice with this powder in October 1862, it was much better than on occasions when the service powder was used. The mean difference of range at 5 degrees on these two occasions is only 20·1 yards, and the mean deflection 1·9 yards. The initial velocity for the common shell, weighing 74·4 lbs., with a charge of 10 lbs. of 2 A 4 powder, is 1,329 feet; with a charge of 10 lbs. service powder, is 1,259 feet; and with a charge of 11 lbs. is 1,314 feet. The intended trial of this gun, in comparison with muzzle-loading guns rifled in other systems, having been taken out of the hands of the Ordnance Select Committee, they can express no opinion of its relative merits; and there is a question still under consideration, whether the numerous zinc projections on the projectile will stand the rough usage of service; but viewed as an experimental gun, the Committee see no reason at all why it should not be paid for.

App. No. 13.
Min. 7687.
5746.
Min. 7616.
Min. 7111—7669.
Min. 8226.
80—G.N.—551.
73—3—3397.
Min. 7901.

(signed) *J. St. George.*
President, O. S. C.

(7543.)

1671 K.—ARMSTRONG'S 70 Pr. M. L. 6-grooved Shunt Gun. Expl.: No. 180, Minute 6951.

Calibre 6·4 inches;—length 9 feet 1 inch;—weight 60 cwt.;—grooves 6, width 0·94 inch, depth 0·15 inch. Twist 1 turn in 45 calibres. Shells contain 5 lbs. 6 ozs. powder.

Secretary submits the results of practice with this gun, repeated in accordance with Minute 7174, with arrangements to prevent the quoin from jumping. See *ante*, Minute 7148.

Gun 17½ feet above plane.

Date.	Number of Rounds.	Elevation by Quadrant.	Actual Elevation.	Mean Weight of Projectile.	Mean Reduced Time of Flight.	Ranges. Min.	Ranges. Max.	Ranges. Mean.	Mean Difference of Range.	Mean Observed Deflection.	Mean Reduced Deflection.	Remarks.
1862:		Charge 11 lbs.		*76·6 lbs.	*Seconds.*	*Yds.*	*Yds.*	*Yds.*	*Yds.*	*Yds.*	*Yds.*	
29 September -	10	2°	2° 17′	Length. 12·3 ins.	3·37	1,040	1,238	1,143	38·3	3·4	0·7	
								1,222	38·7		1·1	Minute 7148.
29 „ -	10	5°	5° 9′	„	6·95	2,178	2,360	2,278	53·9	6·9	3·4	
								2,322	48·7		3·1	„
29 „ -	10	10°	10° 5′	- -	12·08	3,770	4,016	3,878	77·6	23·9	4·1	
								3,825	107·7		5·7	„
2 October -	5	10°	10° 5′	- -	13·40	4,090	4,254	4,169	47·6	27·6	2·9	
		Charge 10 lbs., except the last 5 rounds.										
29 September -	10	2°	2° 19′	†68·5 lbs. Length. 16·5 ins.	3·34	1,042	1,115	1,073	23·2	1·3	0·7	
								1,197	51·7		1·3	Charge 11 lbs.
29 „ -	10	5°	5° 9′	„	6·64	2,117	2,254	2,186	41·9	6·1	1·1	
								2,478	19·3		2·4	„
	10	5°	5° 9′	64 lbs.	6·74	2,172	2,254	2,225	16·6	1·3	2·4	On 23d June.
26 „ -	3	10°	10° 5′	68·5 lbs.	12·30	3,722	3,847	3,798	51·0	19·9	0·8	
29 „ -	7	10°	10° 5′	- -	12·55	3,692	3,812	3,738	33·9	20·0	2·5	
2 October -	5	10°	10° 5′	- -	13·34	4,140	4,232	4,176	25·4	29·9	2·9	Charge 11 lbs.
								4,132	94·4		2·9	„

* Solid shot. † Common shell—shunt, plugged.

Boxer's lubricating wads used, with a damp sponge for the first 15 rounds, then a dry one, which caused less fouling; some wads were found too high. The 14th round was in the gun three days, and fired without difficulty. No difficulty in loading.

The practice, although still inferior to that of June 23d, is rather better than the practice in August, as entered in *smaller type*. Minute 7148.

(7148.)

1671 K.—Armstrong's 70 Pr. m. l. 6-grooved Rifled Shunt Gun, No. 30. Expl.: No. 180. Minute 6951.

Weight 60 cwt.; length 9 feet 1 inch; calibre 6·4 inches; spiral $\frac{1}{45}$ diameters; grooves 6; width 0·95 inch, depth 0·11 inch.

Secretary submits report of practice with this gun.

Gun above plane 17 feet.

Date.	No. of Rounds.	Elevation by Quadrant.	Nature of Projectile.	Mean Time of Flight.	Ranges.			Mean Difference of Range.	Mean Observed Deflect.	Mean Reduced Deflect.	Remarks.
					Min.	Max.	Mean.				
1862:				*Sec.*	*Yds.*	*Yds.*	*Yds.*	*Yds.*	*Yds.* *	*Yds.* *	
August 6 -	10	2°	Common Shell. 74·062 lbs	3·46	1,133	1,290	1,197	51·7	4·1	1·3	
„ 6	10	5°	„	7·22	2,441	2,509	2,478	19·3	15·8	2·4	
	10	10°	„	13·02	3,841	4,249	4,132	94·4	41·6	2·9	1 unsteady.
„ 11 -	7	2°	Solid Shot. 71·312 lbs	3·37	1,143	1,262	1,222	38·7	1·4	1·1	
„ $3\frac{1}{2}$	6	5°	„	6·95	2,262	2,438	2,322	48·7	2·8	3·1	
„	6	10°	„	12·67	3,667	3,988	3,825	107·7	5·8	5·7	

* The deflection of the gun is allowed for on the tangent scale.

The gun was mounted on a garrison sliding carriage.

See Minute 7140.

Appendix, No. 14.

App. No. 14.

ARMSTRONG VENT-PIECES—FAILURE OF, &c.

Ordnance Select Committee.

(Committee Minute, No. 5747, 18/1/62.—Report, No. 2077, 10th January 1862.)

4648. Subject:—1671 D b.—Armstrong's 40-pounder guns.
Vent pieces.

73—3—2185. W. O. paper, 16/8/61. Stating that it having been brought to the notice of the Secretary of State that both wrought iron and steel vent-pieces have recently failed in the trial of 40-pounder Armstrong guns, the Committee are requested to give their immediate and earnest attention to the subject, with a view of devising some means for overcoming so serious a defect in these guns, and to furnish an early report.

Committee's Report.

The Committee have the honour to report the results of experiments carried on at Shoeburyness, 4/10/61, to test wrought iron vent-pieces for 12-pounder, 20-pounder, 40-pounder, and 100-pounder guns; the vent-pieces were of the ordinary thickness, but had their sides hollowed out to allow for expansion. Fifty

Fifty rounds from each gun were fired as rapidly as the gun could be served, and laid on the target. App. No. 14.

The vent-pieces were not altered in shape or injured in any respect.

Although in this instance the vent-pieces have stood the test without exhibiting any signs of weakness, the Committee are still unable to assert that the wrought iron vent-pieces are not liable to fracture, owing to the uncertainty which appears to exist in obtaining uniformity in the manufacture, for it is now obvious that these vent-pieces can be produced so as to stand, even without strengthening, and that the question of strength is merely one of quality of manufacture.

(signed) *J. St. George*,
President, O. S. C.

ORDNANCE SELECT COMMITTEE.

(Committee Minute, No. 6301.—Report, No. 2214, 31st March 1862.)

SUBJECT :—1671 b.—Armstrong's Guns. Vent-pieces. 5070.

I. Proposed alteration in position of vent.
II. Solid breech piece; half wrought iron ; half shear steel.

73—3—2291.

W. O. paper, 4/10/61. Transmits Sir William Armstrong's remarks in reference to Report 1863, Minute 4981.

He thinks that to make a fair comparison between wrought iron and wrought iron combined with shear steel; the vent-pieces should have the vent in them as at present; and that the question of the vent being placed in the gun should be treated separately.

COMMITTEE'S REPORT.

THE Committee have the honour to report the result of experiments to ascertain (1) whether vent-pieces made of wrought iron in front, and of shear steel behind, would be superior in point of strength to vent-pieces made wholly of one or other material.

2d. Whether any advantage would be gained as regards the strength and durability of the vent-piece, by making it a breech-piece only, omitting the vent, and boring the latter in the gun itself, as with smooth-bored ordnance.

The gun which the Committee received authority to try in this manner was the 40-pounder (No. 91), which was in Captain Cole's Cupola, when so many vent-pieces were fractured (Min. 5076), and was suspected to exercise some special effect on its vent-piece.

Fired 10 developing rounds of $6\frac{3}{4}$ lbs. 21. 11. 61, without injury.	Letter (A). Strengthened vent-piece of wrought iron.
Fired 1 proof, and 10 developing rounds without injury.	(B). Strengthened vent-piece, the front half of wrought iron, the rear half of steel.
Cracked with one proof, round of 10 lbs., 6. 1. 62.	(C). Strengthened breech-piece of wrought iron, without a vent, fired through a vent in the gun.
Cracked with one proof, round, 6. 1. 62.	(D). Strengthened breech piece, the front half of wrought iron, the rear half of steel, without a vent.
(A). Strengthened wrought-iron vent-piece of the service pattern as above.	Fired two proof rounds through the vent in the gun, its own vent not being stopped. It was uninjured, 6. 1. 62, and 15. 1. 62.
(E). Strengthened breech piece of wrought iron without a vent.	Fired one proof round and 10 developing rounds without perceptible injury, 17. 3. 62.
(F). Similar to the last.	Fired one proof round, which bulged it at the sides 0·051 inch, the ring becoming detached in consequence of the access thus given to the gas. The breech-piece was also cracked behind.
(G). Similar to the last.	Fired one proof round with the same result, the sides bulged 0·039 inch, the ring came off, and a crack appeared behind.
(H). Similar to E. F. G.	Fired one proof round and 10 developing rounds, without other injury than a lateral bulge of 0·030, caused by the proof round.

Thus, it appears that out of six solid 40-pounder breech-pieces, four have given way.

App. No. 14.

The Committee were not prepared for this result, which would appear to show that the perforation of the vent in the breech-piece is not a source of weakness, and, consequently, that nothing would be gained in point of strength by venting Armstrong guns in the ordinary way.

The breech-pieces, made of half wrought-iron and half of steel, exhibited no superiority over those made wholly of wrought-iron.

The Committee feel that they cannot express too strongly their sense of the necessity of leaving nothing untried that offers a reasonable probability of leading to improvement in the form, quality, or mode of manufacture of vent-pieces; and, as they understand from Sir W. Armstrong that a quality of Swedish iron, known as C ℄ (C. Crescent), is now coming into use, which they have not tried, they request permission to have four solid breech-pieces made of this material to compare with C, D, F, G of the above list.

(signed) *J. St. George,*
President, O. S. C.

ORDNANCE SELECT COMMITTEE.

6503.

(Committee Minute, No. 7341.—Report, No. 2560, 14th November 1862.)

73—3—2907.

SUBJECT:—1671 G b. Armstrong's 110-pounder B. L. gun.

Failure of three wrought-iron vent-pieces.

W. O. 21. 4. 62. Forwards for Committee to see, a report from H. M. S. "Emerald," Queenstown, 28/ 3/ 62, that three wrought-iron vent-pieces were slightly cracked in firing 33 rounds, of which nine were blank; a steel vent-piece in constant use remains uninjured.

COMMITTEE'S REPORT.

The Committee regret that, by an oversight, no report was made on Minute 7841, an omission which they have now to supply. The officer commanding H. M. S. "Emerald" reported on 28th March that three wrought-iron vent-pieces developed fissures in firing 24 rounds of service ammunition and nine blank cartridges, in all 33 rounds. These vent-pieces were forwarded to the Committee, who decided, after communication with Sir William Armstrong, to deliver them over to the Inspector of Artillery to be subjected to further firing, to ascertain how far the fissures which appeared externally extended through the substance of the iron, and were of a dangerous character. The results were reported by Lieutenant Colonel Strange on the 7th July, and will be found stated in the annexed abstract.

No. 1063. Fired three rounds of 11 lbs. charge, and one round 14 lbs. charge, when it split through from back to front, and the cross head was blown off.

No. 989. Fired four rounds with 11 lbs. charge, and seven rounds with 14 lbs. charge, when the crack opened so much that no more rounds were fired for fear of injury to the gun.

No. 1096. Fired three rounds with 11 lbs. charge, and 40 rounds with 14 lbs. charge, when the increase in the width of the crack rendered it difficult to remove the vent-piece, and the further test was stopped.

The average of the three gives a strength adequate to stand three rounds of 11 lbs., and 16 rounds of 14 lbs., after the first appearance of such fissures as are described.

The Committee are not aware of any other direct conclusion that can be drawn from the occurrence than that wrought-iron vent-pieces have a less uniform strength than was at first imagined; very few of them, however, comparatively speaking, have failed; and none, so far as reported to the Committee, since the introduction of (C ℄) Swedish iron. The only explanation Sir William Armstrong can offer is, that the vent-pieces must have been defective, but it is not apparent what the defect is.

(signed) *J. St. George,*
President, O. S. C.

1671. G b.—Armstrong's 110-pounder, B. L. Gun. App. No. 14.

Three wrought-iron vent-pieces which failed on board Her Majesty's Ship "Emerald." Minute 6503. 7272.

Inspector of Artillery, 27/7/62 and 29/8/62. Reports the result of the testing of these vent-pieces, Minute 6750:—

Vent-piece.	Number of Rounds Fired.	Charge.	Remarks.
No. 989. Slight crack, extending vertically nearly the whole diameter of the back projection - - - -	4	11 lbs.	No alteration in crack.
	7	14 lbs.	At the third round the crack slightly increased, and gradually continued to do so up to the sixth round. At the seventh round the crack opened considerably. The proof was stopped for fear of injuring the gun.
	11		
No. 1096. Slight crack, about 4 inches long, round the left side of the back projection - -	3	11 lbs.	No alteration in crack.
	40	14 lbs.	From the first to the seventh round no alteration was visible; at the eighth round the crack slightly increased, and gradually continued to do so up to the thirty-ninth round, and the face of the vent-piece expanding horizontally; at the fortieth round the proof was stopped, owing to the difficulty in removing the vent-piece after firing.
	43		
No. 1062. Cracked about half way round the projection at the back - - - -	3	11 lbs.	No alteration in crack.
	1	14 lbs.	The cross-head was blown off, and the vent-piece split through from back to face.
	4		

The vent-pieces, in their present state, are submitted for Committee's inspection.

Ordnance Select Committee.

(Committee Minute, No. 7937.—Report, No. 2602, 10th December 1862.)

Subject:—1671.—Accidents—Armstrong Matériel. 7842.

Cross Head and Handles of 40-pounder vent-piece blown off during practice on board H. M. S. "Zebra."

W. O. by Minute 18/11/62. Transmits for opinion, a report, 16/8/62, received through Admiralty, from H. M. S. "Zebra," upon the blowing away of the cross head and handles of a 40-pounder vent-piece, by which two men were slightly injured. 73—3—3381.

There is every reason to suppose that the vent-piece was properly screwed home. The accident is attributed to the giving way of a thread of the breech screw. The vent-piece itself was not blown out.

Committee's Report.

The Committee have to remark, that, as far as they can gather from the Reports and Minutes referred to them, the vent-piece, of which the cross-head and handles were blown off on board H. M. S. "Zebra," in August last, was not only of steel, a material which is known to be unreliable, but was also one of the earliest patterns, 0·6 inch thinner than 40-pounder vent-pieces have been made for the last 12 months. The Committee do not think that the fracture of a portion of the thread of the breech screw can have been the cause of the accident, although there was a surmise that a similar occurrence on board the "Trusty" might have contributed to the remarkable fracture of vent-pieces observed in trying Captain

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Coles' cupolas. With that doubtful exception, they have had no occurrences of the kind which was not clearly traceable to the vent-piece not being screwed tight *e. g.* on board.

H. M. S. "Marlborough"	- -	December 1861	- - Min. 5837.
H. M. S. "Excellent"	- - -	December 1861	- - „ 5720.
Shoeburyness	- - - -	May - 1860.	
Shoeburyness	- - - -	April - 1862	- - „ 6058.
H. M. S. "Agamemnon"	- -	May - 1862	- - „ 6919.
Fort Cumberland	- - - -	July - 1862	- - „ 7316.
H. M. S. "Greyhound"	- - -	May - 1862	- - „ 7155.

In all these cases the accident was confessedly due to the vent-piece getting a shock by not being home. And although the Committee are far from affirming that a cross-head cannot be blown off under other circumstances if the metal is very inferior, although the vent-pieces are all severely proved, it appears to them probable, that had the gun been examined by an officer after the accident, and before the handle was touched, it might have been found so in this instance, notwithstanding the strong impression to the contrary of the captain of the gun.

(signed) *J. St. George,*
President O. S. C.

ORDNANCE SELECT COMMITTEE.

(Committee Minute, No. 7883.—Report, No. 2603, 10 December 1862.)

7883. SUBJECT:—1671 b. Accidents—Armstrong Matériel.

Fracture of 110 Pr. vent-piece and upsetting of Guns, Nos. 302 and 307, on traversing platforms.
Injury to sights, carriage, &c.—Plymouth.

73—3—3342. W. O. by Minute 24/11/62 Transmits for consideration, report of an accident which occurred while practising with the 110-pounder guns mounted at Plymouth Citadel:—

1. At the usual inspection, the vent-pieces stuck, and were so difficult to extract, that practice was abandoned after firing six rounds. 12 lbs. charges used, without compressors.
2. By direction of Inspector General of Artillery, 14 lbs. charges were then used, without compressors, and the following are the results:—

——	No. of Rounds.	Result.	Injury.
No. 307 Gun -	1	Front of traversing platform, raised.	—
„	2	Platform raised, as shown in diagram submitted.	—
„	3	Platform raised. Gun and Carriage fell backwards.	Left thumb screw broken; carriage damaged; two hand quoins broken.
No. 302 Gun -	1	Ditto - - - - - -	Right and left trunnion sights broken; right tangent scale bent.

Compressors were then fitted, and after 15 rounds from each of these guns—14 lbs. charge, the vent-piece of No. 302 was cracked, and two small quoins broken. On a former occasion the carriage of No. 302 gun was disabled at third round—a crack extending from behind trunnion to rear of carriage.

COMMITTEE'S REPORT.

The Committee have carefully perused Colonel Shuttleworth's reports on the accidents which occurred in September last at Plymouth Citadel, with 110-pounder guns, principally at the inspection of the 5th Brigade, Royal Artillery, by the Inspector General of Artillery. These accidents, as at first described, are (1) That in the first use of the 110-pounder guns, with service charge, they recoiled, and fell backwards. (2.) On the next occasion, minor casualties occurred. (3.) Subsequently a vent-piece failed. (4.) Finally a gun-carriage gave way, being, as Colonel Shuttleworth observes, an accident on each day of practice. With respect to the first complaint, it has been elicited, by subsequent inquiry of Field Marshal His Royal Highness the Commander in Chief, that on the occasion referred to, the two guns which overset, No. 307 and 302, were fired with full service charge of 14 lbs. without

without compressors, or the adoption of other means of checking recoil, although compressor were supplied for the purpose. It is generally expected of officers, that when platforms are wet, or when from any other cause the recoil is inconveniently great, they shall resort to some means of checking it, the simplest of which is to sprinkle sand on the platform, but compressors would always be used if provided. The first round gave full evidence that some such means were required in this instance, and as they were not employed it is impossible to feel surprise at the result. The Committee have ascertained, that although the 110 pounder, of 82 cwt., is a light gun for a 14 lb. charge with so heavy a shot and has always a considerable recoil, it has been repeatedly fired with 12 lbs. and 14 lbs. charges at Shoeburyness, without compressors. They have been supplied with all carriages issued since February 1862, and have been since furnished to all carriages previously issued, without them. Colonel Taylor states that the recoil on a clean platform, with 14 lbs. charge, and no compressor, is 9 feet to 9 feet 6 inches; sand put on reduces it 2 feet, and the compressor reduces it 3 feet, and he makes the judicious remark, that the action of the compressor itself will vary with the amount of moisture in the atmosphere, and other circumstances, and that the judgment of the officer in charge should be exercised so as to permit a fair recoil as least injurious to the stability of the platforms and racers, which a tightly screwed compressor severely shakes. The consequences of the present accident, as regards the guns, do not appear to have been very serious, being confined to the bending of one tangent scale, the breaking of two thumb screws (leaving one serviceable for each gun), and the breaking of the trunnion sights of one of the guns, No. 302; those of the others were uninjured. The dispart sight of a smooth bored gun would have been liable to the same injury.

The splitting of the wrought-iron vent-piece of No. 302 is more serious, and the Committee receive, with increasing anxiety, the reports of such occurrences. There have as yet been few of these since the introduction of wrought-iron, and none since the introduction of Swedish iron of D brand (C crescent), but it is not to be disguised that the continuance of this system of breech-loading will be endangered if, notwithstanding every exertion to find the best material nature affords, and all proper care and skill in the use of it, such accidents prove to be of frequent occurrence.

They are rarely dangerous, but they must ultimately shake confidence in the gun, and may disable it at a critical moment.

If breech-loading is retained, it will then become necessary to adopt some system which is not liable to them.

The Committee stated in a recent report, that since the abandonment of steel and the adoption of a thicker pattern, very few accidents of this kind have been reported. The present accident was one of those counted on that occasion.

(signed) *J. St. George,*
President O. S. C.

ORDNANCE SELECT COMMITTEE.

(Committee Minute, No. 8238.—Report, No. 2659, 19th January 1863).

SUBJECT:—1671 b. Armstrong's Guns. Failure of vent-pieces. 40-pounder on board "Pelican." 8175.

1. W. O. by Minute 22/10/62. Transmits for Committee's observations, a letter from Commander Brock, of the "Pelican," dated Malta, 5/9/62, (received through Admiralty), reporting that the vent-piece (No. 165 B., R. G. F.) of the 40-pounder gun on board that ship, was observed to have a crack in its rear of about 2·0 inches in length, and 0·1 inches in width, during practice with solid shot on the 29th of October last. 57—2—7122.

2. Admiralty, by letter dated 1/1/63, informs that 31 rounds were fired with this vent-piece previous to injury reported above. Impressions of the vent-piece are submitted. 7317.

COMMITTEE'S REPORT.

The Committee have the honour to report, that on inquiry at the Royal Gun Factories, it appears that the 40-pounder vent-piece, No. 165 B, the failure of which after 31 rounds was reported by Commander Brock, on the 5th September 1862, was one of the first made in that department of wrought iron. Mr. Anderson attributes its want of endurance to the material, which he states to have been since abandoned as unfit for the purpose: it was English iron. The Committee are not aware of anything further to be said on the subject.

(signed) *J. St. George,*
President O. S. C.

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Appendix, No. 15.

ARMSTRONG'S FUZES.

ORDNANCE SELECT COMMITTEE.

(Committee Minute, No. 6344.—Report, No. 2220, 4th April 1862.)

(6344.) SUBJECT:—1671 q. c.—Armstrong's Pillar Fuzes.

(6098.) Question as to sensitiveness of composition. Modifications proposed by Superintendent Royal Laboratory.

Sir W. Armstrong, 25/3/62, in reply to the Committee, expresses his objection to the modifications in the pillar fuze proposed by the Superintendent Royal Laboratory.

1. He does not approve of any increase of strength in the studs on the guard ring: they are strong enough to resist the common tests—greater substance would prevent their acting with reduced charges. It is essential that they should act when the heat is not crushed in, as in striking sideways after ricochet, which he deems a very effective action.

2. He deprecates any alteration in the regulator, which is adjusted to resist impact on water, and no more.

3. He thinks the alteration of the cover unnecessary and injurious.

4. He maintains that no case at all has been made out against the detonating composition now in use, to require the substitution of the Moorsom composition; he has no objection to that composition if it will do, but believes that it is not sensitive enough to act when a shell strikes on the side, and is also liable to deteriorate in keeping.

5. In conclusion,—looking to the long series of experimental stages through which the pillar fuze has reached its present perfection, he trusts that it will not be lightly tampered with.

COMMITTEE'S REPORT.

The Committee have the honour to state, for the information of the Secretary of State, that they are unable to report at present on the sufficiency of the substitution of Moorsom's composition for Sir W. Armstrong's composition in the pillar fuze, as desired by the Superintendent Royal Laboratory, in consequence of Lieutenant-Colonel Boxer having taken the occasion to make a number of other changes in the construction of the fuze, and of their not having been furnished with the exact fuzes demanded.

The Committee have fired thirty-seven 100-pounder common shells with pillar fuzes, specially prepared with Moorsom's composition, and with the other changes above referred to, namely, a deeper recess, a stronger guard, and a removeable head, and the results were satisfactory.

Sir W. Armstrong, however, objects to the whole of these changes, in a letter, of which copy is enclosed, and being aware of the great attention he has devoted to the perfecting of the pillar fuze, and the long succession of improvements applied to it, they think it due to him to adhere to the first intention of making no other change, except the change of composition, until good cause is shown for it.

The Committee further agree with him, that even the composition need not be altered, until it has been perfectly proved that the Moorsom composition is in all respects as good. No case has been made out against the composition he employs, when properly made, the sole accident which has occurred, having happened with composition improperly made.

The Committee have renewed their requisition for pillar fuzes, with the composition above altered.

(signed) *J. St. George,*
President O. S. C.

The Secretary Ordnance Select Committee. App. No. 15.

Sir, 8, Great George-street, West, 25 March 1862.

Referring to your letter of the 22d instant, on the subject of alterations in the pillar fuze proposed by the Superintendent of the Royal Laboratory, I proceed to remark,—

1st. With respect to the studs on the guard ring. These were made just sufficiently strong to save the fuze from ignition, when dropped in a shell upon iron, from the height prescribed as a test by the Committee. That test I believe to be abundantly sufficient, and I consider that any increase in the strength of the studs would not only be superfluous, but would also be attended with the objection of preventing the liberation of the pillar when low charges were used. I am quite aware that when the shell penetrates point foremost into hard timber, the cover of the fuze is sufficiently crushed to insure ignition, independently of the liberation of the guard ring; but when the shell strikes sideways, as it will generally do after graze, the action would be entirely prevented, if the guard ring retained its original place. I attach great weight to this objection, being satisfied that the most effective shells would be those fired with low charges, and striking sideways, after grazing the surface of the water a little short of the enemy's ship; and I think it would be highly unwise to sacrifice this advantage, for the sake of an imaginary increase of safety.

2d. I also deprecate any alteration in the strength of the regulator, which was most carefully adjusted to resist impact upon water, without being more than sufficient for that purpose.

3d. The proposed variations in the form and construction of the cover are, in my opinion, equally unnecessary, and add nothing to the safety of the fuze, while they involve an additional part, and the additional operation of screwing. I can see no advantage in being able to open the fuze, and I consider a stamp struck down with a hammer over the detonator, to be a far more secure test of the adequacy of the clearances, than would be afforded by ocular examination. A screwed joint would also be less impervious to air and moisture than one secured by rivetting, and would also be subject to the risk of the screw becoming loose, and falling out, in which case the danger of explosion would be imminent. I can see no utility in altering the depth or dimensions of the recess in the cover. The limits of variation allowed in the distance between the detonator and the surrounding recess, are quite sufficient to meet error in manufacture, and any increase in the space would only have the effect of requiring more motion in the pillar to produce ignition, and would consequently tend to render the fuze slower in its action, without affording any advantage.

4th. With regard to the alteration of the detonating mixture, I maintain that not the slightest case has been made out against the safety of the present composition. I have no objection, however, to the substitution of the Moorsom composition, if it be proved equally efficient under all conditions. I have already informed the Committee, that the trials I made of that composition, led me to the conclusion that it could not be depended upon, when the shell struck on its side, and I may add, that I also found it liable to diminish greatly in sensibility by keeping, when prepared in the most sensitive form.

In conclusion, I would observe, that every point connected with the action of this fuze, has been so carefully considered and tested by experiments, that I hope the Committee will not be induced to sanction any alteration in it, without being thoroughly satisfied that it is necessary, and that no ill effects will result from its adoption.

I have, &c.
(signed) *W. G. Armstrong.*

Ordnance Select Committee.

(Committee Minute, No. 6677.—Report, No. 2309, 30th May 1862.)

Subject:—Armstrong Pillar Fuzes, with Moorsom Composition.
With reference to Report, No. 2220; Minute, 6344.

Committee's Report.

The Committee have the honour to report that they fired, on the 21st instant, a number of pillar fuzes, made in the Royal Laboratory, with Moorsom detonating composition, but in other respects resembling the service pattern.

1. They were fired in 110-pounder and 40-pounder shells to *récochet* on water, namely, five each at ¾°, 1½°, and 2° elevation, and three at 3° elevation; in all 33. None of these exploded on the first graze, and only one exploded at all, namely, a 40-pounder, fired at ¾°, on the second graze.

2. Twenty-five 110-pounder shells, and twenty-five 40-pounder shells, with these fuzes, were then fired at 9-inch oak targets, with the following results at 1,500 yards:—

	110-*Pdrs.*	40-*Pdrs.*
Hit and burst	4	7
Missed and burst on graze on the sand	0	0
Missed and did not burst on graze	10	8
Burst prematurely	0	0
	14	15

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At 500 yards:—	110-*Pdrs.*	40-*Pdrs.*
Hit and burst	6	8
Missed and burst on graze	0	0
Missed and did not burst on graze	3	2
Burst prematurely	0	0
Stripped and did not burst	1*	0
Stripped, rolled along the sand, and burst nearly 3,000 yards down the range	1*	0
	11	10

Report, No. 220. Minute, No. 6344.

Thus, it will be seen, that all the shells which struck the target burst, and that some of them burst in *ricochet* on the sand. The Committee consider that these results, combined with those reported on the 4th ultimo, go far to prove that the Moorsom composition is sufficiently sensitive for pillar fuzes; but they have not the means of ascertaining whether shells, with these fuzes, striking irregularly after *ricochet* on water, will act as well as those prepared with the composition used by Sir William Armstrong, and they now recommend that 50 pillar fuzes of each composition be sent to Her Majesty's ship "Excellent," to be fired at the target ship to test this point.

50 Elswick composition; 50 Moorsom composition.

(signed) *J. St. George,*
President O. S. C.

ORDNANCE SELECT COMMITTEE.

(Committee Minute, No. 7615.—Report, No. 2513, 22d October 1862)

SUBJECT:—Armstrong Pillar Fuzes, with Moorsom Composition, with reference to War Office Minute, 25/8/62, on 75—7—644, Min. 7251, and former Report, No. 2220., Min. 6344.

COMMITTEE'S REPORT.

THE Committee have the honour to report that they witnessed a trial of pillar fuzes, prepared with the Moorsom and Elswick compositions respectively, at Portsmouth, on the 8th instant, with the results stated below, and are led to the conclusion that the Moorsom composition, viz., equal parts of sulphuret of antimony (*s. b.*), chlorate of potassa, possesses all the sensitiveness necessary for this form of percussion fuze, and should be hereafter adopted for what is called the Elswick composition, namely:—

Minute, 6086.

Chlorate of potassa	16 parts.
Powdered glass	6 „
Amorphous phosphorus	8 „
Powdered shellac	5½ „

The amorphous phosphorous containing 10 per cent. of calcined magnesia.

2. The trial was made against the "Sultan" target ship, from a gun-boat, 375 yards distant, but moored up to 100 yards, in consequence of the swell. After nine rounds of 110-pounder shells, with each nature of fuze, the following is an abstract of the results:—

Pillar Fuzes:	HITS. En Ricochet and Burst.	HITS. Direct and Burst.	HITS. En Ricochet no Burst.	Grazed Water, No Burst Riocheted Over.	Burst on Graze.	Doubtful.	Total.
110-pounder, Moorsom C.	8	5	0	5	0	1	19
110-pounder, Elswick C.	3	1	0	3	4	0	11
40-pounder, Moorsom C.	8	0	1	0	1	0	10

With the exception of one fuze, with Moorsom composition, which burst on grazing the water in a 40-pounder shell, and one 40-pounder that was found unexploded on board, the whole of the shells, with these fuzes, 29 in number, succeeded perfectly.

Whereas, out of 11 shells fired with fuzes made up with the Elswick composition, four burst on grazing the water. The high velocity with which they struck the water partly accounts for these bursts; but it must be remarked, that three of them took place when the target ship was at 375 yards distance, and the velocity on striking was consequently not so great as that of many of the other fuzes which did not burst. The Committee have taken steps

* These two shells were Royal Gun Factory make, and did not bear the Inspector of Artillery's mark.

steps to ascertain, by trial at Shoeburyness, whether this liability exists at the longer ranges, which are more generally employed; but as the Moorsom composition appears to be free from it, while quite sufficiently sensitive to act in pillar fuzes, either directly or after ricochet on water, it may be at once preferred for future manufacture, and the Committee are desirous of repeating the experiment tried in 1860, and then unsuccessful, of applying it to time fuzes. The form of the time fuze, and the mode of detonation, having undergone a considerable change since 1860, it is possible that Moorsom composition may now be found sensitive enough for those fuzes also. App. No. 15. Report, 2309. Minute, 6677. Report, No. 1221. Minute, 2563. Report, No. 978. Minute, 1733.

(signed) *J. St. George,*
President O. S. C.

Ordnance Select Committee.

(Committee Minute, No. 6679.—Report, No. 2311, 2d June 1862). (4373.)

Subject:—1671. 2. c.—Armstrong's Time Fuze for Field Service.—Improved pattern.

W. O. 5/7/61., transmits copy of letter 27/6/61, from Sir W. Armstrong, relative to an improved time fuze for field service.

He states that as the present pattern time fuze has been found subject to several imperfections, he has been making experiments with a modified pattern of this fuze, which he has now nearly perfected, and its advantages will be so decided, that he considers it advisable to discontinue the manufacture of the present pattern. (75—7—395.)

In the new arrangement, no loose priming is required. The detonator is in immediate contact with the powder, and the detonating apparatus is contained in the body of the fuze where it cannot be affected by a fall. The fuze composition is protected on the outer circumference by metal instead of paper.

Adds, that he will shortly submit a time fuze for naval service, constructed upon the same principle, and which will admit of being kept fixed in the shell, and regulated without removal.

W. O. notifies that directions have been given, suspending the manufacture of the present pattern time fuze.

Committee's Report.

The Committee have the honour to report the conclusion of a series of experiments, having for their object, the improvement of the present Armstrong time fuze, pattern B., which was sealed in June 1861, and which have led to the fuze distinguished as E. 2., which they now recommend for sealing as a field service fuze. Civ. 704. Art. 283.

2. The essential difference between these fuzes and the B pattern, consists in the removal of the concussion arrangement from the head to the body of the fuze, and the first of the series were the C fuzes of which the Committee made a very favourable report in January last, (Report No. 2065) and which were actually ordered to become the pattern, (Minute 5942); this order however has remained in abeyance, in consequence of the proposal of one small improvement after another prior to sealing, constituting the patterns D. E. and E 2. The substitution of D for C, was reported on 10th March, (Report No. 2193, Minute 6205); about a fortnight later, E was substituted for D, from which it differs in having a channel cut round the central pillar, and in other details. Min. 5702, 75-7-503 Min. 5702—6387—6679.

The Committee have fired altogether, of C pattern 70; of D pattern 47; of E pattern 107; a number which would be insufficient if these fuzes involved any novelty of principle, but which they think sufficient to warrant their present recommendation, regarding them as successive improvements upon an established fuze, addressed to the removal of successive minor defects.

3. The fuze as now made, appears to the Committee, likely to be free from most of the defects of the earlier patterns.

1. The body being of brass instead of white metal, the thread of the screw cannot shear on discharge.
2. There is no iron or brass washer.
3. The priming is much better protected than before.
4. There is a larger body of priming, affording a stronger flash.
5. Spaces which formerly contained air, which air had to be driven out before the flame, and appeared to introduce some anomalies, are now filled with compressed powder.
6. Broader bearings generally afford a better protection from damp.

Sir W. Armstrong himself states that it does not appear to him that the fuze is susceptible of any further improvements so far as field use is concerned. Min. 6455.

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The successive improvements have been as follows:—

C 1. white metal body.
C 2. brass body.
D Ditto different detonating hammer, white metal socket and point.
E Ditto brass socket, steel point, channel round the pillar, primed with grained powder.
E 2. Ditto brass socket, enlarged steel point; the detonating hammer enlarged, and about 20 grains heavier; channel filled with compressed powder.

4. The Committee enclose an abstract of the result of firing 54 fuzes of the last pattern, and 10 of the previous pattern. These latter had been subjected by Mr. Abel to the greatest degree of artificial cold he was able to produce for one month.

The temperature varied between 32° Fahrenheit and 15° Fahrenheit, a range of 47°.

It will be seen that the fuzes were not at all affected by it. The others were fired in 6-pounder, 12-pounder and 20-pounder guns, to ascertain whether the rate of burning is uniform in field calibres. It appears not to be so, and to ensure precision, it may be expedient to issue them with scales graduated like those of the experimental fuzes, in inches; but this can be determined after a longer trial, and before supplies are ready for issue. It will make practically little difference whether the time fuze for 1,200 yards is set to 3·7 seconds or to 1·9 inches.

In the 6-pounder 1-inch on the scale, corresponds to 2·08 seconds in time of burning.

In the 12-pounder to 1·93 seconds.

In the 20-pounder to 1·79 seconds.

The error that will result in the longest time of flight, namely, eight seconds, if we take the 12-pounder scale for the whole, will be 3·60 seconds for the 6-pounder, and 0·56 for the 20-pounder, corresponding to 130 or 140 yards of range in both cases, a quantity large enough to deprive the mean scale of all precision in those calibres at long ranges. If the retention of the scale of seconds rather than the scale of inches is considered an object, it will be easy to adjust the tabular time to meet each case, but it will then differ somewhat from the real time of flight.

6-pounder, 137 yds.
20-pounder, 131 yds.

The Committee are unwilling to delay the approval of the improved fuze for this point, and would rather fire a larger number before deciding it. They have received the first experimental supply of a similar but somewhat larger fuze for naval purposes, the trial of which will be proceeded with as soon as possible.

(signed) *J. St. George,*
President O. S. C.

6679. 6516.

1671 c.—Armstrong's Time Fuze. Pattern E².

Secretary submits reports of practice with new pattern E² time fuzes, to ascertain rate of burning.—Minute 6442.

DATE.	Nature of Gun.	Fuze.	Fuze set to		Number of Rounds.	Mean Time of Burning.	Greatest Difference per Inch.	Mean Time of Burning, 1-inch.	REMARKS.
			Inches.	Seconds.					
1862.		*Time.*				*Seconds.*	*Seconds.*	*Seconds.*	
21 May -	6-pr. -	(E²)	1	–	6	2·13	0·07	2·13	
			2¼	–	6	4·53	0·12	2·01	
			3½	–	6	7·35	0·04	2·10 / 2·08	
21 May -	12-pr.-	,,	1	–	6	1·90	0·10	1·90	1 failed to burst.
			2½	–	6	4·38	0·09	1·95	
			3½	–	6	6·80	0·00	1·94	
			3½	–	10	6·72	0·05	1·92 / 1·93	Fuzes which have been subjected to intense cold.
21 May -	20-pr.-	,,	1	–	6	1·83	0·07	1·83	
			2½	–	6	4·00	0·00	1·78	1 not observed.
			3½	–	6	6·12	0·66	1·75 / 1·79	1 blind.

App. No. 15.

Ordnance Select Committee.

(Committee Minute, No. 7477.—Report, No. 2486, 3d October 1862.)

Subject:—1671 c:—Armstrong's o. p. Time and Concussion Fuzes. Reports on the failure of these fuzes—from Batteries of Royal Artillery. (7273.)

W. O. by minute 28. 8. 62. Forwards for early report of the Committee, a minute of the A. A. General, R. A., 26. 8. 62, covering correspondence on the subject of the unsatisfactory state of the fuzes used at the annual practice by Armstrong Gun Batteries (E & B, 8th Brigade, and K, Horse Brigade) of the Royal Artillery, in Ireland. 75—7—646.

His Royal Highness the Commander in Chief considers it desirable that the observations of the Commandant of the School of Gunnery on the above should be fully considered.

Committee's Report.

The Committee have the honour to report that they have carefully considered the observations of the Commandant of the School of Gunnery in respect to the unsatisfactory state of the time fuzes for Armstrong guns.

Colonel Taylor's report on the failures of these fuzes in so many instances, expresses all the Committee have to say on the subject.

It appears sufficiently proved that the old pattern time fuzes that were at one time considered perfection, are now very faulty; and this deterioration may arise from the fuzes of this description not standing the test of time and vicissitudes of weather, thereby proving their unfitness for the service, or from the fuzes when first made for experiment having been manufactured with an amount of care which cannot be bestowed in the manufacture of large quantities. On account of the inefficiency of the old pattern B fuze the Committee recommended for sealing (Report, No. 2371. 12/7/62, Minute 6812) a new time fuze, E_2, which they believe will be found to be free from all the objections found in the old one. Every precaution has been taken to protect these new fuzes from deterioration through damp, and the Committee hope that they will prove as successful when manufactured for service, as they have done when supplied for experiment.

The Committee entirely concur in Colonel Taylor's recommendation that the old pattern time fuzes should be withdrawn at once, and with this view they recommend that the new pattern E_2 time fuze be supplied as speedily as possible to all batteries, and to all Her Majesty's ships, for boat and field service at foreign stations, and the old pattern fuzes withdrawn; that no battery or ship be allowed to proceed abroad without being supplied with the E_2 time fuze, and the new concussion fuze; and that all batteries and ships at home stations be furnished with the new fuzes, as fast as they can be manufactured and supplied. The fuzes (time) for the larger natures of Armstrong guns are still in a most unsatisfactory state, and the Committee are of opinion that no time should be lost in calling the attention of Sir William Armstrong to this serious defect in the system of projectiles for the Naval and Garrison Service.

(signed) *J. St. George*,
President, O. S. C.

Ordnance Select Committee.

(Committee Minute, No. 7767.—Report, No. 2556, 12th November 1862.)

Subject:—1671 c.—Armstrong's o. p. Time Fuzes B^2 (R. L. make), Minute 7233. (7653.)

W. O. 24/10/62. Requests the Committee to forward a copy of the abstract of practice made with time fuzes upon which they founded their recommendation of the pattern B (Art. 283, Cir. 704); and the Committee are further desired to report more fully in what particular respect the fuzes of R. L. make, referred to in Report 2504, Minute 7558, differ from the sealed pattern B, which it is presumed did not furnish such unsatisfactory results, otherwise it would not have been adopted. 75—7—684.

Note.—Pattern A fuze which contained all the essentials of B fuze, was adopted into the service without this Committee's recommendation. B fuze was recommended (Minute 3142) as being an improvement on A, in several particulars, Minute 3007.

Committee's Report.

1. The Committee have the honour to report that in order to give an intelligible answer to the inquiry how the B pattern time fuze came to be introduced, and to what tests it was first subjected, it is necessary for them to go back to the first introduction of the Armstrong guns.

App. No. 15.

2. In proposing a system of breech-loading rifled artillery in which there is no escape of flame past the shot, it was necessary for Sir William Armstrong to contrive a time fuze which should be lighted mechanically on discharge. This he accordingly did, and the time fuze, which he designed to meet the requirements of the case, became inseparably associated with his segment shell, and an integral part of the new system.

The Committee do not find that the fuze was specifically submitted for approval to the War Office before November 1858, when the first special Committee on rifled cannon included a drawing of it in their Report to Major General Peel, nor can they find precise particulars of practice with it earlier than September of that year, but from allusions in Colonel Mitchell's report of 9th February 1858, it was evidently in use at that date; so much was at that period left to be worked out by Sir William Armstrong and Colonel Mitchell in private trials, that the official records are very incomplete.

3. In this way, without specific approval, or apparently much discussion of its fitness for general service, Sir William Armstrong's time fuze came to be treated as a part of his system; the batteries sent to China were equipped with it, and it was virtually in the service when the present Ordnance Select Committee received for the first time from the War Office, 18/2/60, for their consideration and report, drawings of these fuzes, as a part of the ammunition of the 12-pounder gun.

80—A.—563.

4. The fuzes thus sent were not cut in section, the drawings were not lettered for reference, and there was no written description with them. They were returned to the War Office (Report, No. 663, 2d March 1860) for these additions, and on the 16th March the fuzes were included in the partial Armstrong field equipment, then pronounced complete for service. There was a great pressure to get this equipment complete, and circumstances would not have permitted a fresh series of experiments to test the fuzes, even if doubts had then existed of their being suitable for the service. In reality, however, the ingenuity of their construction, the satisfaction they had given in more than two years of preliminary trial, and the authority attaching to Sir William Armstrong's recommendation, led to their adoption, with little or no misgiving as to their being entirely serviceable.

Report No. 701. Minute 646—63.

This pattern (A) was sealed in April 1860.

Minute 1052. 80—A.—637.

5. The improvments which constitute B pattern time fuze grew out of a refusal of the Peninsula and Oriental Company, in May 1860, to take some of these fuzes (A) to China, on the ground of their containing a dangerous composition. This led to the trial of Moorsom's composition, and while these experiments were in progress reports began to come in of the fuzes becoming unserviceable from damp and rust, which again led to many suggestions and trials of improved ways of packing them. Ultimately, a more secure mode of packing was approved of, and to meet other objections Sir William Armstrong, in December 1860, produced B pattern fuze, the subject of the present inquiry.

Minute 2363.

Minute 3007.

Minute 3173.

The Committee fired 80 of these fuzes in January 1861. There occurred one premature explosion, and 16 failed to burst; but Sir William Armstrong expressed his full confidence that this was due to a cause that he could readily remove; and it was removed in great measure. The Committee can trace the firing of 448 of the B pattern time fuzes with the following results:—

Acted properly	403
Blind	40
Burst near the muzzle	4
Burst prematurely, but not near the muzzle	1
	448

Including A and B patterns together, the reports are—

Acted properly	651
Blind	79
Burst near the muzzle	6
Burst prematurely, but not near the muzzle	1
	737

The number of blind shells is undoubtedly considerable, namely, more than 10 per cent* (10·7), but with the fuzes of Royal Laboratory make, now under consideration, it was 11 to 25, or 44 per cent., showing some specific defect which cannot be attributed to the pattern, and which the Committee hope to discover, but they do not think it necessary to wait this inquiry before satisfying the Secretary of State: (1.) That there was no immediate alternative in 1861 but to accept the best time fuze that then existed; and (2.) that there were good grounds for supposing it an efficient fuze.

Minute 7558.

Minute 7748. 57—2—7007.

P.S.—The further questions raised in the Secretary of State's letter of the 7th instant will be considered in a separate report.

(signed *J. St. George,*
President O. S. C.

App. No. 15.

Ordnance Select Committee.

(Committee Minute, No. 7991, 10/12/62.—Report, No. 2608, 15th December 1862.)

Subject :—1671 c.—Armstrong's o. p. Time Fuzes B^2 (R. L. make), Minute 7233. (7977.)

W. O., by Minute 5/12/62, transmits for Committee's information, memo. 26/11/62, from Superintendent R. L., in which he states that more than ordinary care was taken in the construction of the B_2 time fuzes; and that with the exception of a few of those first manufactured, owing to the metals lead and tin, from want of experience, not being properly mixed, he believes them to be as perfect as they can well be made. 75—7—727.

W. O., with reference to the latter part of Report 2556, Minute 7767, asks if the Committee have yet been able to discover the cause of their failure. *See* Minute 7717.

Committee's Report.

The Committee have the honour to inclose a copy of a letter which they have received from Mr. Abel, giving the result of his examination of six of the time fuzes, Royal Laboratory make, B pattern, which were handed to him out of the number issued for the experiments described in their Report No. 2504, Minute 7558, and unexpended; Mr. Abel found one of the India-rubber rings completely detached from the cap, and another partially so. On 10 of the same supply, which the Committee have examined, there were three of which the India-rubber ring stuck to the wrong surface, and did not move with the cap, but adhering to both surfaces was partially torn off and wrinkled between them; none of these fuzes would have acted. There were three more, of which the India-rubber ring was very slightly held to the cap.

The Committee agree with Mr. Abel, that it is needless to enquire further for a cause of the failures which occurred on the 26th September, five out of these 16 having been unserviceable, and three others nearly so, from the cause now given; but it may be added that four out of the Committee's 10, blew the top of the screw nut out, a thing which ought not to happen, and is very capable of preventing the action of the fuze; in one of the four instances it did so.

(signed) *J. St. George,*
President, O. S. C.

Chemical Department, Royal Arsenal, Woolwich, S.E.
9 December 1862.

Sir,

I have the honour to inform the Ordnance Select Committee that I have carefully examined the six-time fuzes referred to in your letter of the 18th ultimo, and that I was unable to discover any cause of a chemical nature to which a failure of the fuzes could be ascribed.

On attempting to move the discs of the fuzes, however, I found that, in one instance, the India-rubber washer had become altogether detached from the surface of metal, and was clinging firmly to the paper which is pasted over the fuze composition. On attempting to set another of the fuzes, the washer was also clinging to the paper, and partially detached from the metal.

These circumstances would perfectly account for the failures of those particular fuzes, if set without an inspection of the washer, as the fixture of the latter upon the paper would, of course, protect the fuze composition from ignition by the flame of the priming charge.

I have, &c.
(signed) *F. A. Abel,*
Chemist to the War Department.

Appendix, No. 16.

App. No. 16.

ARMSTRONG PROJECTILES.

Ordnance Select Committee.

(Committee Minute, No. 5679—5681 (30/12/61).—Report, No. 2061, 3d January 1862.)

2705. Subject:—1671 g.—Armstrong's Guns. Projectiles.

New Method of Coating with Lead.

80—a.—874. W. O. 16/11/60. Transmits copy of letter 12/11/60, from Sir W. Armstrong, proposing a new method of securing the adhesion of the lead coating to his projectiles without the process of tinning the surface,—by cutting the grooves of the projectile in the form of a dove-tail,—this will also effect a reduction in the price.

Captain Noble, r. a., 12/11/60. Informs that two shells so prepared, one a 100-pounder, the other a 40-pounder, together with a 40-pounder shell, coated in the ordinary way, have been forwarded for inspection.

In the two latter shells the lead is partially stripped off to enable the O. S. C. to judge, by actual force, of the tenacity with which in the two cases the lead adheres.

Committee's Report.

With reference to former reports as to the relative merits of the two methods of attaching the lead generally practised in the Royal Laboratory and at Elswick respectively: viz., zinc solder and undercut grooves, the Committee have now the honour to submit for consideration of the Secretary of State, the results of some practice which appear to them to warrant the universal employment of the method of attachment by zinc solder, which they believe to be cheaper than the other.

The first is an abstract of the results of bursting 20 undercut, and 20 zinc shells in a cell, showing the number of fragments into which they burst.

Deducting the segments themselves, of which there are 49 in the 12-pounder, and 30 in the 6-pounder shells. The results are:—

	Over ½ oz.	Under ½ oz.
Fragments of 12-pounder undercut	53·3	94·5
Ditto - 12-pounder zinc	23·4	26·5

The Committee attach little importance to the fragments of less than half-ounce weight, the majority of which are small flat pieces of lead, portions of the burster, &c., neither calculated by their form or weight to have any serious effect at a few feet distance.

There is no difference worth mention in the number of the larger masses, from six ozs. upwards; the zinc shells show the greatest tendency to divide into medium sized fragments of the most effective character, and have the smallest proportion of very small ones, which are comparatively ineffective.

Min. 5679. The next abstract gives the results of target practice with 12-pounder segment shells of these two natures.

It will be seen (Table 1), that as regards range and accuracy, there is no perceptible difference, nor is it to be supposed that there would be.

The zinc shells have about 20 yards more range than the undercut, but this must be considered as accidental.

With respect to the effect on targets, 68 undercut shells, and 51 zinc shells, were burst under conditions affecting the targets, that is to say, somewhere in front of them; shells that burst behind are not counted on either side.

Taking

Taking a proportionate part of the effects for 50 shells of each nature, we have,— App. No. 16.

	Splinters and Segments on 50 zinc shells.	Splinters and Segments on 50 undercut shells.
Through	327	174
Lodged	138	162
Struck	90	90

It is scarcely necessary to observe that the effect of segment shells on small targets is exceedingly fortuitous; a very great number must be fired to eliminate all the irregularities arising from their bursting sometimes a little nearer, sometimes a little further off; the foregoing result confirms the previous conclusion, that there is no reason, as far as concerns the efficiency of the shells, why the lead of all natures should not henceforward be attached by zinc solder, and for the sake of uniformity, and to avoid double patterns, the Committee recommend that this be adopted as soon as possible.

It has been ascertained that they are not in any way more affected by exposure to the weather. Min. 5144

(signed) *J. St. George*,
President, O. S. C.

5679.

1671 g. Armstrong's Projectiles.

Method of attaching the Lead—Undercutting *versus* Zinc.

Secretary submits abstract of comparative practice with 12-pounder Shells, lead attached by undercutting and by zinc solder respectively.—Minute 3871.

Axis of Gun, 3½ feet above plane.

Table I.

Date, &c.	Lead attached by	No. of Rnds.	Elevation.	Mean reduced Time of Flight.	Ranges. Min.	Ranges. Max.	Ranges. Mean.	Mean diff. of Range.	Mean observed Deflect.	Mean reduced Deflect.	Remarks.
1861:				*Seconds.*	*Yds.*	*Yds.*	*Yds.*	*Yds.*	*Yds.*	*Yds.*	
3 December. Wind.	Undercutting	10	2°	3·32	1,057	1,109	1,087	10·6	2·3	0·5	None stripped.
1 ←		10	5°	6·78	2,057	2,098	2,081	11·7	3·7	1·1	Nine broke at graze.
Barometer. 30·25		10	10°	12·12	3,317	3,439	3,399	24·2	5·7	0·8	Broke at graze, attributed to the action of the buck shot added to make up the weight.
,,	Zinc	10	2°	3·40	1,066	1,125	1,101	12·4	1·9	0·6	—
S1. ←		10	5°	6·86	2,087	2,140	2,111	12·3	3·6	1·4	Broke at Graze.
,,		10	10°	Not observed	3,393	3,455	3,418	18·1	6·9	0·9	Nine broke at graze.
,,											

Undercut shells—no lead found on the screen before the gun.

Zinced shells—no lead found on the screen before the gun.

Table II.

Live Shells. Time and Concussion Fuzes. Cast-iron Bursters—Powder cakes, 425 grains. Minute 4790.

Date, &c.	Lead attached by	Elev. Fuze.	Range to Target.	No. of Rounds Fired.	No. of Rounds that burst in front of Target.	Effect on Targets. S.	Effect on Targets. L.	Effect on Targets. T.	Burst behind Target.	Did not burst.	REMARKS.
1861 : 25 Nov.		1° 17′	800	15	11*	17	48	55	1	2	* 1 more burst at muzzle.
3-4		1 24									
	Undercutting	2° 21′	1,200	15	13	29	41	47	2†	—	† 1 of these at 2d graze at 2,270 yds.
		2 25							1	,,	at 2,320 yds.
,,		3° 22′	1,600	15	12‡	23	32	41	2	—	‡ 1 more at muzzle.
		3 30									
,,		4° 48′	2,000	15	14	34	55	33	—	1	
		4 38									
					50	103	176	176			
			Propn. - -		37	75	128	128			
,,		1° 17′	800	15	12	16	28	53	2*	1	* At 2d graze, at 1,900 yds. & 1,800 yds. respectively.
		1 24									
,,		2° 21′	1,200	15	8	16	19	33	6†	1	† 2 at 2d graze, at 2,000 yds. & 2,350 yds. respectively.
	Zinc - -	2 25									
,,		3° 30′	1,600	15	9	32	26	158	5‡	1	‡ 1 at 2d graze at 2,700 yards, one fuze found unserviceable.
		3 30									
,,		4° 49′	2,000	15	8	11	27	46	6§	—	§ 2 at 2d graze at 2,900 yards and 2,960 yards respectively.
		4 38									
					37	75	110	290			
			Propn. - -		37	75	128	128			

Table III.

Live Shells. Time and Concussion Fuzes. Bursters—Service pattern.

28 and 29 Nov.		—	700	7	4	7	16	35	1	2	
3 ,, 4	Undercutting	2° 20′	1,200	5	5	10	22	18	—	—	
		4° 10′	1,800	9	5*	2	7	8	1	2	* 1 more burst at muzzle. 1 only blew out fuze and bottom.
				21	17	19	45	61			
,,		—	700	7	3	6	10	10	4	—	
,,	Zinc - -	2° 10′	1,200	7	6	8	19	26	1	—	
,,		4° 8′	1,800	5	5	3	4	8	—	—	
				19	14	17	31	44			

(5681.) 1671 g.—Armstrong's Projectiles.

I. Method of Attaching the Lead—Undercutting *versus* Zinc.

II. Cast-Iron Bursters—Powder Cakes. Minute 4790.

Secretary submits an abstract of Quartermaster Behenna's Report of Experiments made on the 18th December 1861, by bursting 12-pr. and 6-pr. Segment Shells (lead attached by different methods) with Cast Iron and Tin Bursters—Powder Cakes. Minute 4790.

No. of Shell burst.	Mode of Attaching the Lead.	MEAN NUMBER OF FRAGMENTS. Weighing—ozs.								Total Mean No. of Fragments.
		6 and upwards.	5 to 6.	4 to 5.	3 to 4.	2 to 3.	1 to 2.	½ to 1.	Under ½.	
	12-Pr. Shells:									
10	Undercutting -	2·1	0·0	0·1	2·5	7·8	56·6	33·2	94·9	197·2
10	Zinc - -	2·5	0·3	1·5	3·2	11·1	51·8	17·9	58·5	145·8
	6-Pr. Shells:									
10	Undercutting -	2·2	0·1	0·3	1·5	4·7	8·7	40·3	55·1	112·9
10	Zinc - -	2·5	0·5	1·1	2·4	5·3	10·1	30·5	26·5	79·9

Segments, 12-pr., 42 each, 1 oz. 1 dr.; 7 each of 13 drs.; 6-pr., 30 each, 14 drs.—*See* Minutes 5679–5680.

Ordnance Select Committee.

Committee Minute, No. 6717.—Report, No. 2317, 9th June 1862.

Subject:—Old pattern round bottom 110-pounder common shells.

With reference to previous Report, No. 2236, of 9th April 1862.

Committee's Report.

The Committee have now fired the 30 releaded 110-pounder round bottom shells referred to in their last report, with the result set forth in the inclosed printed abstract. The shells had been releaded on Sir William Armstrong's recommendation, and were of three gauges, the first 10 were 0·01 inch higher in gauge than the service pattern, the next 10 0·02 inch, and the last 10 0·03 inch higher. Notwithstanding which, they turned over nearly as badly as before.

In the practice of January 8th, 23 shells out of 45, either turned over in flight, or were unsteady to a degree unknown to the service pattern. Min. 5823.

In the practice of March, 10 shells out of 12 exhibited the same defect. Min. 6401.

In the present practice, with releaded shells of higher gauge, 9 shells out of 30 have done so. It is evident therefore, that the old pattern round bottomed 110-pounder common shells are not fit for the service, and the Committee recommend that they be broken up. Min. 6717.

There is an additional reason for condemning them, namely, that the projection of the circular base encroaches so much on the powder chamber, as not to leave space enough for the cartridge, making it very difficult to load when lubricators are used.

(signed) *J. St. George*,
President, O. S. C.

Minute 6717.

1671 G g.—Armstrong's 110-pounder round bottomed shells.

Secretary submits reports of practice with unstrengthened 110-pounder gun, No. 53, firing round bottomed shells releaded to an increased diameter. Minute 6328.

Gun above plane 17½ feet.

DATE.	No. of Rounds.	Elevation.	Mean Diameter of Shot.	Mean Time of Flight.	RANGES.			Mean difference of Range.	Mean observed Deflect.	Mean reduced Deflect.	REMARKS.
					Minimum.	Maximum.	Mean.				
1862:			*Inches.*	*Seconds.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*	
May 26	5	5°	7·097	5·96	1,586	1,914	1,796	95·6	4·70	4·84	1 Unsteady.
„ 26	3	10°	ditto -	11·40	3,323	3,439	3,386	25·2	18·80	0·93	
„ 28	2	10°	ditto -	11·50	2,452	3,439	2,946	493·5	20·20	7·80	1 turned over.
„ 28	2	5°	7·107	6·00	1,443	1,894	1,668	225·5	2·10	1·10	1 ditto.
„ 29	3	5°	ditto -	6·43	1,590	1,881	1,753	109·0	9·70	11·10	1 ditto.
„ 28	5	10°	ditto -	10·04	1,991	3,431	2,580	619·6	50·20	82·70	3 ditto.
„ 29	5	5°	7·117	6·05	1,368	1,899	1,774	162·8	1·16	1·06	1 ditto.
„ 28	5	10°	ditto -	11·20	2,051	3,466	3,047	398·2	28·60	37·94	1 ditto.

Gun laid at a target 6 × 6 ft.,—distant 1,000 yards.

The vent piece, No. 53, after 8 rounds was slightly cracked.

Great difficulty was experienced in getting the cartridge, 12 inches in length, into the powder chamber—the average space behind the shell being only 10 inches.

Appendix, No. 17.

App. No. 17.

ARMSTRONG'S GUNS (12-POUNDER AND 40-POUNDER) MADE FROM MERSEY IRON (OLD BREECH-LOADING).

Ordnance Select Committee.

Committee Minute, No. 6994—(21/7/62).—Report, No. 2389, 24th July 1862.

(3973.) Subject:—1168.—Mersey Steel and Iron Company.

Supply of 2 Blocks, after Drawings of a 12-pr. and 40-pr. Armstrong Guns.

80—G. N.—388. W. O. 10. 5. 61. Transmits copy of letter 2. 5. 61, from Assistant Superintendent R. G. F., reporting that the 12-pr. block supplied by the Mersey Company, has been bored, turned, and fitted exactly in accordance with a 12-pr. Armstrong Gun, and subjected by his department to the usual proof before being sighted, and completed as a gun. That the result of the proof is, that the powder chamber has become defective in various parts of its length, and exhibits holes and dents to an extent which, if taking place in an Armstrong Gun, would not be passed for service. He forwards impressions showing the nature of the flaws before and after proof, and awaits further instructions.

Committee's Report.

Min. 3973. The Committee have the honour to report that the Mersey Company 12-pr. Gun referred to in their Report No. 1601, which was proved in April 1861, underwent the first part of the usual test for endurance in May last. It was fired 100 rounds with the service charge of 1½ lbs., and shot or cylinders increasing in weight from 12 lbs. to 120 lbs.; on examination the powder chamber was found to have expanded 0·020 inch, the shot chamber 0·002 inch, at 10 inches from the breech, and the same at 12 inches. Slight flaws were apparent at 14·25 inches, 23 inches, and 40·5 inches from the muzzle; there were also a number of slight longitudinal fissures in the powder chamber, indicating the usual eating away of the soft metal between the fibres, and a flaw of some size along the top, but the gun was not reported unserviceable. The gun has now gone through the second part of the usual test, by firing 30 rounds with a double charge of powder, namely, 3 lbs. and shot increasing as before from 12 lbs. to 120 lbs., three rounds in each series.

The powder chamber has bulged or expanded 0·057 inch more at 8 inches from the breech, making a total expansion of 0·077 inch.

The expansion in the shot chamber at 10 inches has increased no less than 0·093 inch, and the one at 12 inches 0·109 inch becoming respectively 0·095 and 0·111 inch in depth.

The

The gun has a large scaly flaw in the powder chamber, and is deeply fissured all round the whole length of the powder and shot chambers; a crack 11 inches long is visible on the exterior of the gun, in line with the scaly flaw before mentioned, but there does not appear to be any communication between them, as water, under a pressure of 200 lbs. per square inch, is not forced through. The gun is unserviceable. App. No. 17.

On the whole, although this gun has exhibited a very great degree of endurance, and is not now burst, it has not come up to the Service Gun (Report No. 1483, Minute 3414), but if the cost of the production be very materially less than that of guns made on the coil system, it may be worth further inquiry; the Committee, however, think it best to postpone any recommendation on the subject until the 40-pounder (Minute 5274) has completed the same trial. This gun (Expl. No. 139) has gone through the first part. 73—3—2379. Min. 6698.

(signed) *J. St. George*,
President, Ordnance Select Committee.

ORDNANCE SELECT COMMITTEE.

(Committee Minute, No. 7055 (1/8/62).—Report, No. 2403, 4th August 1862.)

SUBJECT:—1168.—Mersey Steel and Iron Company. 2968.

Supply of 2 Blocks after Drawings of the 12-pounder and 40-pounder Armstrong Guns.

W. O. 19. 12. 60. Notifies that the Gun Blocks ordered from the Mersey Steel and Iron Company, in accordance with the recommendations contained in Committee's Report 981, Minute 1762, have arrived at Woolwich. 73—3—1563.

Requests the O. S. C. to state in what manner they wish these blocks to be disposed.

COMMITTEE'S REPORT.

The Committee have the honour to report that the experimental 40-pounder gun made in a block, delivered by the Mersey Steel and Iron Company in December 1860, 73—3—1562, has been tested for endurance, and although not burst, is now in an unserviceable state. Min. 2968.

This block was originally somewhat smaller at the breech end than the sealed pattern 40-pounder, its diameter being 15·625 inches, instead of 16·438 inches, a difference in thickness of 0·406 inch.

It has fired 100 rounds with the service charge of 5 lbs., and cylinders, increasing in weight, from 40 lbs. to 400 lbs.; also 17 rounds with double the service charge, viz., 10 lbs., and with the 40-pounder service shot; total, 117 rounds.

The result is that the bore is deeply fissured all round from 75 inches from the muzzle to the breech end of the powder chamber. The powder and shot chambers are also expanded, as shown in the following table:—

	Vertical Expansion.				Horizontal Expansion.			
	From Breech End.	Original Diameter.	Present Diameter.	Difference.	From Breech End.	Original Diameter.	Present Diameter.	Difference.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
In the Powder Chamber	2	4·96	4·991	·031	2	4·96	4·985	·025
	6¾	- -	5·006	·046	6¾	- -	5·004	·044
	12½	- -	5·028	·068	12½	- -	5·024	·064
In the Shot Chamber	14½	4·825	4·920	·095	14½	4·825	4·912	·087
	20½	- -	5·199	·374	20½	- -	5·139	·314

The Committee have recently reported on the endurance of a 12-pounder of the same manufacture—Report 2389, Min. 6994. They have no information before them by which they can judge whether guns of this material and mode of manufacture can be furnished at a less cost than is now paid for guns made on the coil system; but they consider that both these guns have shown an endurance, if not fully equal to that of guns made on that system, yet at least ample for the requirements of the service, if it is accompanied by the same power of resisting a very great number of service charges.

This latter species of endurance has not been tested, and if made the subject of direct experiment, could not be tested without firing some thousands of rounds from a gun of each make.

The Committee request to be furnished with particulars of cost, that they may be in a position to form an opinion whether it is worth while, with a view to ultimate economy of manufacture, to test more Mersey Company guns.

(signed) *J. St. George*,
President, Ordnance Select Committee.

App. No. 17.

ORDNANCE SELECT COMMITTEE.

(Committee Minute, No. 7368 (22/9/62).—Report, No. 2461.)

7294. SUBJECT:—1168.—Mersey Steel and Iron Company.

12-pounder and 40-pounder B. L. (Armstrong) Rifled Guns made from Blocks of Mersey Wrought Iron (Minute 1951).

73—3—3245. W. O. 29. 8. 62. Informs the Committee (with reference to the inquiry contained in Report 2403, Minute 7055) that the original cost of these blocks supplied by the Mersey Company was as follows, viz.:—

	Cwt.	qrs.	lbs.		£.	s.	d.
40 pounder weight	40	1	3	at 59s. cwt.,	118	16	4
12 „ „	12	0	0	„ 58s. „	34	16	–

The expense incurred in Royal Gun Factory in boring, rifling, sighting, browning—including vent pieces, breech screw, lever and tappet, guide plate, &c., &c., complete as service guns:—

	£.	s.	d.
40 pounder - - - - - - - -	66	13	4½
12 „ - - - - - - - -	27	13	10½
This gun has yet to be sighted, browned, and made fit for service, which will cost - -	13	–	–
	£. 40	13	10½

The Secretary of State awaits a further report from the Committee.

7365. 1168.—Mersey Steel and Iron Company.

Question as to comparative cost of 12-pounder and 40-pounder Armstrong guns as at present manufactured, with similar guns made of Mersey iron.

73—3—3261. W. O. 12. 9. 62. Informs the Committee (with reference to Report 2446, Minute 7294), that the prices at which the Elswick Ordnance Company are now prepared to supply 40-pounder and 12-pounder guns, are 249 *l.* and 90 *l.* respectively.

NOTE.—The cost of these guns made of Mersey iron are 185 *l.* 9*s.* 8½*d.* and 75 *l.* 19*s.* 10½*d.* respectively. See Minute 7294.

COMMITTEE'S REPORT.

BY the information conveyed in War Office letters under acknowledgment in respect to the relative cost of Armstrong's 40 and 12-pounder guns on the coil system made at Elswick, and of those manufactured from steel blocks supplied by the Mersey Company, and ultimately completed in the Royal Gun Factories, it appears that by the employment of the latter a saving in cost of manufacture will be effected to the extent of about 74 *l.* per 40-pounder gun, and 15 *l.* per 12-pounder gun.

On these grounds, and from the fact of a very satisfactory amount of endurance having been obtained from the 40-pounder and 12-pounder guns of Mersey steel, already furnished for experiment, and recently reported on (see Report No. 2403, 4. 8. 62; Minute 7055, and Report No. 2389, 24. 7. 62; Minute 6994), the Committee beg now to recommend that the Mersey Steel Company be called upon to supply three 40-pounder blocks and three 12-pounder blocks similar to those previously furnished, in order that they may be bored, rifled, and finished in the Royal Gun Factories for further experiment.

(signed) *J. St. George,*
President, Ordnance Select Committee.

Appendix, No. 18.

WHITWORTH'S 12-POUNDER AND 70-POUNDER GUNS— INITIAL VELOCITIES.

ORDNANCE SELECT COMMITTEE.

(Committee Minute, No 6577.—Report, No. 2281, 17th May 1862.)

SUBJECT:—1943 B. C. Whitworth 3-inch shot of different lengths for 12-pr. Guns. 6495.

W. O. 17/4/62. Notifies that Mr. Whitworth is informed that experiments will be made for initial velocity of shot (14 in number) commencing with a rifled spherical shot, and increasing in length by half a diameter up to 4 diameters, as soon as he delivers them. 30—W.—566.

COMMITTEE'S REPORT.

THE Committee have the honour to forward for the information of the Secretary of State, a copy of Lieutenant Noble's abstract of practice with the Whitworth breech-loading and muzzle-loading 12-pr. guns. It will be seen that the former gives a velocity as high as 1326·3 feet, with its service charge of 1 lb. 12 oz., being 60 or 70 feet more than the velocity of an Armstrong 12-pr. shot with the same charge. This difference is due to the gun being no less than 11·9 calibres longer than the service Armstrong 12-pr., for the muzzle-loading Whitworth 12-pr., which is nearly the same length as the Armstrong 12-pr. (0·9 calibre shorter) gave a less velocity than the latter with both charges. The Committee have still to fire the shot of different lengths which Mr. Whitworth has recently supplied.

(signed) *J. St. George*,
President, O. S. C.

MINUTE 6577.

1943 B. C. Whitworth's 12-pr. B. L. and M. L. Guns.—Velocity of Shot.

Lieutenant H. Noble, 9/5/62. Reports the result of experiments to determine the initial velocity of Whitworth's 12-pr. shot.

Length of Bore - - - -		B. L. Gun. 36·4 Cal.		M. L. Gun. 23·6 Cal.	
		Initial Velocity.	Lost in 30 Yards.	Initial Velocity.	Lost in 30 Yards.
	Rounds.	*Ft.*	*Ft.*	*Ft.*	*Ft.*
Charge 1 lb. 12 ozs. - -	5	1326·3	10·2	1214·3	9·0
„ 1 lb. 8 ozs. - -	5	1238·4	9·1	1141·8	8·2
„ 1 lb. 8 ozs. - -	6	1244·3	9·1	—	—

Standard 12-pr., length 24·5 calibres, charge 1 lb. 8 ozs., 5 rounds, 1,176·0 feet.
The deflection of the Whitworth shot on ricochet was extraordinary.

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ORDNANCE SELECT COMMITTEE.

(Committee Minute, No. 6996, 21/7/62.—Report, No. 2393, 30th July 1862.)

6996.
£0—W.—607.

SUBJECT:—1943 B. C. Whitworth's 12-pr. B. L. and M. L. Guns.—Initial velocity.

W. O. 16/7/62. Requests the Committee to state when they will be able to furnish their further Report upon the initial velocity of the Whitworth 12-pr. shot.
See Report 2281, Minute 6577, and subsequent Minutes 6763—6924.

COMMITTEE'S REPORT.

THE Committee have the honour to report that a series of experiments have been made with Navez's electro-ballistic apparatus, with a view to the determination of the initial velocity of shot from Mr. Whitworth's 12-pr. guns, and to compare them with shot from Armstrong 12-pr. guns, with the following results:—

First, as to the service shot of both guns.

Mr. Whitworth's 12-pr. shot is three calibres in length, and fired with a service charge of 1 lb. 12 ozs. To secure comparison, it has also been fired with the same proportionate charge as the Armstrong shot, and the latter with the same proportion as the Whitworth charge.

TABLE I.

Whitworth 12-pr. Service Shot or Shells.

DATE.	Gun, and Length in Calibres.		Shot: Lbs.	Charge.		Velocity.		Powder.
				Lbs.	Prop.	Observed at 90 Feet.	Reduced to Muzzle.	
1862:		*Cal.*				*Ft.*	*Ft.*	
24 July -	M. L.	23·6	11·75	2·00	0·170	1,255	1,264	b.
12 Mar. -	„	„	12·15	1·75	0·144	1,223	1,214	b. a.
29 May -	„	„	12·07	1·75	0·145	1,221	1,229	a. 2 A. 4
12 Mar. -	„	„	12·15	1·50	0·123	1,133	1,142	b.
16 July -	„	„	11·75	1·50	0·127	1,162	1,169	b. b. L. G. R. A. 4.
1861:								
3 Dec. -	B. L.	36·4	12·15	1·75	0·144	1,336	1,326	b. 4. 7. 61.
1862:								Lot 345.
29 May -	„	„	12·07	1·75	0·145	1,340	1,350	a.
28 Jan. -	„	„	12·15	1·50	0·123	1,229	1,238	b.
24 April -	„	„	12·15	1·50	0·123	1,233	1,244	b.
24 June -	„	„	12·07	1·54	0·127	1,305	1,315	a.

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Table II.

For Comparison.—Armstrong 12-pr. Service Shot or Shells.

DATE.	Gun, and Length in Calibres.		Shot: Lbs.	Charge.		Velocity.		Powder.	
				Lbs.	Prop.	Observed at 90 Feet.	Reduced to Muzzle.		
1862:		*Cal.*				*Ft.*	*Ft.*		
24 July -	B. L.	24·5	11·75	2·00	0·170	1,336	1,348	b.	
1860:									
11 Sept. -	„	„	11·56	1·75	0·151	1,262	1,272	b.	a. 2 A. 4.
1862:									
16 July -	„	„	11·75	1·75	0·149	1,264	1,274	b.	b L. G. R. / A. 4.
16 July -	„	„	11·75	1·50	0·128	1,167	1,176	b.	
29 May -	„	„	11·75	1·50	0·128	1,247	1,257	a.	

Next, as to the experimental shot of different weights, which Mr. Whitworth obtained permission to try. The comparison in this case is rendered more difficult, by that gentleman having used three different charges. 80—W.—566.

The results are as follows:—

Table III.

Whitworth Experimental Shot.

DATE.	Gun, and Length in Calibres.		Shot.		Charge.		Velocity.		Powder.	
			Weight: Lbs.	Length in Cal.	Lbs.	Prop.	Observed at 90 Feet.	Reduced to Muzzle.		
1862:		*Cal.*					*Ft.*	*Ft.*		
30 May -	M. L.	23·6	3·41	1·0	1·25	0·367	1,914	2,007	a.	
30 May -	„	„	5·94	1·5	2·00	0·336	1,849	1,886	a.	
24 June -	„	„	6·12	1·5	2·00	0·326	1,848	*1,885	a.	a. 2 A. 4.
29 May -	„	„	7·86	2·0	1·75	0·223	1,473	1,491	a.	
29 May -	„	„	10·02	2·5	„	0·174	1,326	1,338	a.	
29 May -	„	„	12·07	3·0	„	0·145	1,221	1,229	a.	
29 May -	„	„	14·58	3·5	„	0·120	1,124	1,131	a.	
30 May -	B. L.	36·4	3·41	1·0	1·25	0·367	2,102	2,210	a.	
29 May -	„	„	6·21	1·5	2·00	0·322	1,867	1,905	a.	
29 May -	„	„	7·86	2·0	1·75	0·223	1,633	1,654	a.	
29 May -	„	„	10·02	2·5	„	0·174	1,450	1,464	a.	
29 May -	„	„	12·07	3·0	„	0·145	1,340	1,350	a.	
29 May -	„	„	14·58	3·5	„	0 120	1,244	1,252	a.	

* Experiment repeated in consequence of these shot of 1½ calibres from the M. L. Gun appearing to give anomalous results in comparison with those from the B. L. Gun.

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TABLE IV.

Armstrong Experimental Shot.

DATE.	Gun, and Length in Calibres.		Shot.		Charge.		Velocity.		Powder.
			Lbs.	Length in Cal.	Lbs.	Prop.	Observed at 90 Feet.	Reduced to Muzzle.	
1862:		*Cal.*					*Ft.*	*Ft.*	
16 July -	B. L.	24·5	5·40	1·00	2·144	0·397	2,089	2,170*	a. a. 2 A. 4.
14 May -	„	„	8·00	1·78	2·00	0·250	1,640	1,662	b. b.
14 May -	„	„	8·00	1·78	2·00	0·250	1,723	1,746	a. L. G. R. / A. 4.

* This velocity, reduced to the same proportionate charge as was used with the Whitworth shot of 1 calibre, becomes 2,083 feet.

The Committee are led to the following conclusions by the foregoing practice:—(1.) Under strictly comparable conditions, that is to say, equal weight of shot, equal charge, and equal length of gun, the Whitworth 12-pr. appears to give an initial velocity below that of the Armstrong gun.

This is probably due to the retardation experienced by the Armstrong shot in passing through the contracted part of the bore immediately in front of it, which permits a steady accumulation of pressure behind it, and is instantly followed by a decrease of friction when the shot emerges into the wider part of the bore. The friction of the Whitworth shot, arising from the very rapid twist of the rifling, concurs to produce the same relative effect.

In the Armstrong 12-pr. the angle of rifling is 4° 44′, and in the Whitworth 12-pr., is 8° 55′.

(2.) By reducing his shot in length, Mr. Whitworth is enabled to attain very high velocities; but this does not appear to be peculiar to polygonal rifling; the same result has been obtained by reducing an Armstrong shot, the only difference being that the form of the latter does not permit so great a reduction in weight as is made in the Whitworth shot of one calibre.

It is yet to be proved, whether such very short projectiles will retain a serviceable degree of precision for short ranges, under either system of rifling.

A leaded shot can be fired from an Armstrong 12-pr. with a charge of 2-5ths, and will attain a velocity of 2,170 feet per second without stripping, one of the shot having been recovered, and found perfectly marked with the rifling.

(signed) *J. St. George,*
President, O. S. C.

ORDNANCE SELECT COMMITTEE.

(Committee Minute, No. 7832.—Report, No. 2574, 24 November 1862.)

4384. SUBJECT:—1943 A.—Whitworth's muzzle-loading homogenous iron rifled guns, hooped, 70-pr. of 70 cwt.

80—W.—450. W. O. 4/7/61. With reference to Report 1613, Minute 3981, informs the O. S. C. that Lord Herbert, at the request of Mr. Whitworth, has sanctioned one of the three 70-pr. guns which have passed proof, being tested for range, accuracy, &c. &c., without any special reference being made to the strength of the metal of which it is constructed.

COMMITTEE'S REPORT.

THE Committee have the honour to submit for the information of the Secretary of State a report of the actual velocity of Mr. Whitworth's projectiles, as fired by the Special Committee on iron plates on the 13th instant at targets distant 600 or 800 yards. It appears that the steel shells, weighing 151 lbs., from the 7-inch gun at 800 yards, were able to penetrate a 5-inch plate, and to pass through 18 inches of teak with a half inch skin of iron behind it, with a velocity of 1,170—1,179 feet per second. A steel shell of 130 lbs. did the same, with a velocity of 1,244 feet, and a steel shot of 130 lbs., with a velocity of 1,203 feet. These velocities having been determined for a point 60 feet short of the target, will be about ·4 feet greater than the velocity on impact. Again, steel shells of 81 lbs. from the 5-inch

5-inch gun at 600 yards, penetrated the 4½ inch plate. with a velocity of 1,104—1,107 feet per second, but did not entirely penetrate the backing. The same was effected by shells of 72½ lbs., with a velocity 1,146—1,148 feet per second. Subject to a similar correction of about ·4 feet. These results are of remarkable interest, as tending to show that a moderate and easily attainable velocity will suffice for the greatest effects of penetration, if the material of which the shot or shell be composed, is of the requisite hardness or temper. There is, therefore, great reason to expect similar results from the guns of the service, when the same material is employed. To Mr. Whitworth, however, will always be due the great distinction of having first effected it. Experiments are in progress that will determine whether the 70-pr. and 110-pr. of the service, can cope with these results. App. No. 18.

(signed) *J. St. George,*
President, O. S. C.

ORDNANCE SELECT COMMITTEE.

(Committee Minute, No. 7906.—Report, No. 2590, 3 December 1862.)

SUBJECT :—2230.—Mr. Westley Richards' * system of breech-loading applied to Ordnance. 5157.

W. O., 14/10/61. Transmits letter 8/10/61, from Mr. Westley Richards, stating that he is desirous of laying before the O. S. C. a plan for breech-loading cannon, which he thinks will be found superior to the one now in use. 80—W.—37.

COMMITTEE'S REPORT.

THE Committee have the honour to report that the 40-pounder gun altered to Mr. Westley Richard's system of breech-loading, which that gentlemen obtained permission in November 1861 to submit at his own expense, was reported ready in September last, and that on the 29th October they proceeded to the first trial at the proof butt, Royal Arsenal. This trial was not entirely successful, and after seven rounds had been fired, Mr. Richards requested a suspension of it, that he might apply some improvement to the mechanism of the breech, and also alter the lubrication and the tin cups. These improvements having been effected, the gun was again ready for trial on the 26th November. Mr. Richards' system is, as described in a former report, substantially the same as that applied to his small arms. There are some slight differences of detail, caused by the greater size of the parts, but a Westley Richards carbine barrel laid on its side will give a very accurate idea of the arrangement, and the first impression conveyed by it is, that it is extremely unsightly and awkward. Its application to a service 40-pr., the trunnions remaining in their old position, has increased its breech preponderance from 5 cwt. 38 lbs. to 12 cwt. 21 lbs. It extends backwards 7·4 inches further than that of the service pattern 40-pounder, measuring from the end of the charge chamber, namely, 22 inches instead of 16·6 inches. The Committee, however, have pleasure in reporting that the apparent awkwardness of the system on this large scale, is an impression not borne out by practice, the breech being worked with great facility, and that it can be worked on either a travelling or naval 40-pr. carriage without their being altered. The trial on the present occasion consisted in firing 50 rounds of service ammunition into the proof butt from a proof slide. The last 20 of these were fired in 9 min. 36 sec. There was no difficulty in loading, except at the 8th round, when the shot was jammed by a piece of paper, left by the previous cartridge. A deep tin cup of a peculiar form was used, fitting the bore easily, and furnished with a loop, to admit of its being pulled out backwards. In seven instances the loop broke, and the cup had to be pushed out by a rammer from the front, but in five of these the cup itself was forced out of shape, by the use of a peculiarly shaped cartridge. One cup was used 17 times, two, 13 times each, seven were used only once. It appears, however, that cups of this form may be generally used repeatedly ; there was very little escape of gas. Considered as a first experiment, the Committee think the result satisfactory, and are favourably impressed by the simplicity of manipulation, and strength of construction attained. Mr. Richards has already produced a second model in wood, which is, in many respects an improvement on the first. He asks leave to construct a 70-pr., at his own expense, to embody these improvements, and the Committee recommend compliance with this request ; they also request authority to test the present gun, No. 183, for endurance for the purpose of testing the breech-loading arrangement; the expense of ammunition, if the gun reaches 100 rounds will be 165*l.* 15*s.* It may be stated that Mr. Richards expresses his confidence that the service guns can, if hereafter required, be altered to his system; and that its introduction, if after adequate trial that should be determined on, need not involve any changes of ammunition or projectiles. It may possibly remove some of the main objections to breech-loading, and in point of strength and simplicity has great claims to further attention. Min. 5485.

(signed) *J. St. George,*
President, O. S. C.

App. No. 19.

Appendix, No. 19.

BOXER'S PERCUSSION FUZES FOR ELONGATED PROJECTILES.

Ordnance Select Committee.

(Committee Minute, No. 5818 (15/1/62).—Report, No. 2096, 20th January 1862.)

3851. **Subject:**—2138.—Lieutenant Colonel Boxer, R.A.—Percussion Fuzes for elongated Projectiles.

75—7—307. W. O. 224/61. Transmits a copy of letter from Lieutenant Colonel Boxer, suggesting that a trial be made with his fuzes (Minute 3306) in the Armstrong shells. He states that it is a cheaper and more simple fuze than the one he understands is about to be adopted, and will meet all the requirements of the service.

Committee's Report.

The Committee have the honour to inclose for the information of the Secretary of State, an abstract of practice with the fuzes, proposed by Lieutenant Colonel Boxer, for elongated shells, by which it will be seen that they are still far from successful. Lieutenant Colonel Boxer has withdrawn the unexpended fuzes, to try and remove their defects.

(signed) *J. St. George,*
President, O. S. C.

5818. 2138.—Lieutenant Colonel Boxer, R.A.—Percussion Fuzes for elongated Projectiles.

With reference to Minute 5060. Secretary submits reports of practice 9 & 10/1/62, to test Lieutenant Colonel Boxer's modified percussion fuzes for elongated projectiles.

Armstrong's 100-pr. and 40-pr. common shells.
Charge 12 lbs. - 5 lbs.
At oak butt, 6 ft. × 6 ft. × 13 ins., at 500 yards.

	Rounds.	*Elev.*	
100-pr.	1	53′	Through, after graze: not burst.
	2	56′	ditto.
	3	59′	Struck: not burst.
40-pr.	4	42′	Missed.
	5	43′	Struck: not burst.

Lieutenant Colonel Boxer has withdrawn the remainder of the fuzes.
The head of the fuze was countersunk about three-quarters of an inch.

	Rounds.	*Elev.*	
100-pr.	5	1°	Struck and burst. Preliminary practice.
	5	45′	

The head of the fuse was flush with the head of the shell.

Appendix, No. 20.

RETURN showing the Number of ARMSTRONG GUNS Manufactured in the ROYAL GUN FACTORIES which were passed by Colonel *Tulloh* while he was Inspector of Artillery; showing the Number and Marks of Identity of each Gun passed, of those rejected, and of those rejected which were afterwards passed for Service, with the Date of their Issue.

Total Number of Guns passed for Service.		Guns passed after First Proof.		Guns rejected after First Proof.		Guns rejected at First Proof, but repaired and passed for Service.		
Number of Gun.	Marks of Identity.	Number of Gun.	Marks of Identity.	Number of Gun.	Marks of Identity.	Number of Gun.	Marks of Identity.	Date of Issue.
1	12-pounder, R.G.F., L.S.	1	12-pounder, R.G.F., L.S.					
2	- ditto -	2	- ditto.					
3	- ditto -	3	- ditto.					
4	- ditto -	4	- ditto.					
5	- ditto -	–	- -	5	12-pounder, R.G.F., L.S.	5	12-pounder, R.G.F., L.S.	13 Feb. 1861.
6	- ditto -	6	- ditto.					
7	- ditto -	7	- ditto.					
8	- ditto -	8	- ditto.					
9	- ditto -	9	- ditto.					
10	- ditto -	10	- ditto.					
11	- ditto -	11	- ditto.					
12	- ditto -	12	- ditto.					
13	- ditto -	–	- -	13	- ditto -	13	- ditto -	22 Aug. 1860.
14	- ditto -	14	- ditto.					
15	- ditto -	–	- -	15	- ditto -	15	- ditto -	13 Feb. 1861.
16	- ditto -	–	- -	16	- ditto -	16	- ditto -	22 Aug. 1860.
17	- ditto -	17	- ditto.					
18	- ditto -	18	- ditto.					
19	- ditto -	19	- ditto.					
20	- ditto -	20	- ditto.					
21	- ditto -	21	- ditto.					
22	- ditto -	22	- ditto.					
23	- ditto -	23	- ditto.					
24	- ditto -	24	- ditto.					
25	- ditto -	–	- -	25	- ditto -	25	- ditto -	15 June 1860.
26	- ditto -	26	- ditto.					
27	- ditto -	27	- ditto.					
28	- ditto -	28	- ditto.					
29	- ditto -	29	- ditto.					
30	- ditto -	30	- ditto.					
31	- ditto -	–	- -	31	- ditto -	31	- ditto -	25 Feb. 1861.
32	- ditto -	–	- -	32	- ditto -	32	- ditto -	21 Aug. 1860.
33	- ditto -	–	- -	33	- ditto -	33	- ditto -	30 Jan. 1861.
34	- ditto -	–	- -	34	- ditto -	34	- ditto -	25 Feb. „
35	- ditto -	35	- ditto.					
36	- ditto -	36	- ditto.					
37	- ditto -	–	- -	37	- ditto -	37	- ditto -	29 Sept. 1860.
38	- ditto -	38	- ditto.					
39	- ditto -	39	- ditto.					
40	- ditto -	40	- ditto.					
41	- ditto -	41	- ditto.					
42	- ditto -	42	- ditto.					
43	- ditto -	43	- ditto.					
44	- ditto -	44	- ditto.					
45	- ditto -	45	- ditto.					
46	- ditto -	46	- ditto.					
47	- ditto -	47	- ditto.					
48	- ditto -	48	- ditto.					
49	- ditto -	49	- ditto.					
50	- ditto -	50	- ditto.					
51	- ditto -	51	- ditto.					
52	- ditto -	–	- -	52	- ditto -	52	- ditto -	25 Feb. 1861.
53	- ditto -	53	- ditto.					
54	- ditto -	54	- ditto.					
55	- ditto -	55	- ditto.					
56	- ditto -	56	- ditto.					

RETURN showing the Number of Armstrong Guns Manufactured in the Royal Gun Factories, &c.—*continued.*

Total Number of Guns passed for Service.		Guns passed after First Proof.		Guns rejected after First Proof.		Guns rejected at First Proof, but repaired and passed for Service.		
Number of Gun.	Marks of Identity.	Number of Gun.	Marks of Identity.	Number of Gun.	Marks of Identity.	Number of Gun.	Marks of Identity.	Date of Issue.
57	12-pounder, R. G. F., L. S.	–	12-pounder, R. G. F., L. S.	57	12-pounder, R. G. F., L. S.	57	12-pounder, R. G. F., L. S.	13 Feb. 1861.
58	- ditto -	58	- ditto.					
59	- ditto -	59	- ditto.					
60	- ditto -	60	- ditto.					
61	- ditto -	61	- ditto.					
62	- ditto -	62	- ditto.					
63	- ditto -	63	- ditto.					
64	- ditto -	64	- ditto.					
65	- ditto -	–	- -	65	- ditto -	65	- ditto -	18 Aug. 1860.
66	- ditto -	66	- ditto.					
67	- ditto -	67	- ditto.					
68	- ditto -	–	- -	68	- ditto -	68	- ditto -	21 Aug. „
69	- ditto -	69	- ditto.					
70	- ditto -	–	- -	70	- ditto -	70	- ditto -	18 Aug. „
71	- ditto -	71	- ditto.					
72	- ditto -	72	- ditto.					
73	- ditto -	–	- -	73	- ditto -	73	- ditto -	13 Feb. 1861.
74	- ditto -	–	- -	74	- ditto -	74	- ditto -	13 Feb. „
75	- ditto -	–	- -	75	- ditto -	75	- ditto -	13 Feb. „
76	- ditto -	–	- -	76	- ditto -	76	- ditto -	13 Feb. „
77	- ditto -	–	- -	77	- ditto -	77	- ditto -	21 Aug. 1860.
78	- ditto -	78	- ditto.					
79	- ditto -	–	- -	79	- ditto -	79	- ditto -	16 July „
80	- ditto -	80	- ditto.					
81	- ditto -	81	- ditto.					
82	- ditto -	82	- ditto.					
83	- ditto -	83	- ditto.					
84	- ditto -	84	- ditto.					
85	- ditto -	85	- ditto.					
86	- ditto -	86	- ditto.					
87	- ditto -	87	- ditto.					
88	- ditto -	88	- ditto.					
89	- ditto -	89	- ditto.					
90	- ditto -	–	- -	90	- ditto -	90	- ditto -	7 July „
91	- ditto -	91	- ditto.					
92	- ditto -	92	- ditto.					
93	- ditto -	–	- -	93	- ditto -	93	- ditto -	22 Aug. „
94	- ditto -	94	- ditto.					
95	- ditto -	95	- ditto.					
96	- ditto -	–	- -	96	- ditto -	96	- ditto -	25 Feb. 1861.
97	- ditto -	–	- -	97	- ditto -	97	- ditto -	13 Feb. „
98	- ditto -	–	- -	98	- ditto -	98	- ditto -	25 June 1860.
99	- ditto -	99	- ditto.					
100	- ditto -	100	- ditto.					
101	- ditto -	101	- ditto.					
102	- ditto -	–	- -	102	- ditto -	102	- ditto -	13 Feb. 1861.
103	- ditto -	103	- ditto.					
104	- ditto -	104	- ditto.					
105	- ditto -	105	- ditto.					
106	- ditto -	106	- ditto.					
107	- ditto -	107	- ditto.					
108	- ditto -	108	- ditto.					
109	- ditto -	109	- ditto.					
110	- ditto -	110	- ditto.					
111	- ditto -	111	- ditto.					
112	- ditto -	112	- ditto.					
113	- ditto -	113	- ditto.					
114	- ditto -	–	- -	114	- ditto -	114	- ditto -	16 July 1860.
115	- ditto -	115	- ditto.					
116	- ditto -	116	- ditto.					
117	- ditto -	117	- ditto.					
118	- ditto -	118	- ditto.					
119	- ditto -	119	- ditto.					
120	- ditto -	120	- ditto.					
121	- ditto -	–	- -	121	- ditto -	121	- ditto -	13 Feb. 1861.
122	- ditto -	122	- ditto.					
123	- ditto -	123	- ditto.					
124	- ditto -	–	- -	124	- ditto -	124	- ditto -	18 Aug. 1860.
125	- ditto -	125	- ditto.					

RETURN showing the Number of Armstrong Guns Manufactured in the Royal Gun Factories, &c.—*continued.*

Total Number of Guns passed for Service.		Guns passed after First Proof.		Guns rejected after First Proof.		Guns rejected at First Proof, but repaired and passed for Service.		
Number of Gun.	Marks of Identity.	Number of Gun.	Marks of Identity.	Number of Gun.	Marks of Identity.	Number of Gun.	Marks of Identity.	Date of Issue.
126	12-pounder, R. G. F., L. S.	126	12-pounder, R. G. F., L. S.					
127	- ditto -	127	- ditto.					
128	- ditto -	128	- ditto.					
129	- ditto -	129	- ditto.					
130	- ditto -	130	- ditto.					
131	- ditto -	–	- -	131	12-pounder, R. G. F., L. S.	131	12-pounder, R. G. F., L. S.	18 Aug. 1860.
132	- ditto -	132	- ditto.					
133	- ditto -	133	- ditto.					
134	- ditto	134	- ditto.					
135	- ditto -	135	- ditto.					
136	- ditto -	136	- ditto.					
137	- ditto -	–	- -	137	- ditto -	137	- ditto -	13 Feb. 1861
138	- ditto -	138	- ditto.					
139	- ditto -	139	- ditto.					
140	- ditto -	140	- ditto.					
141	- ditto -	141	- ditto.					
142	- ditto -	142	- ditto.					
143	- ditto -	143	- ditto.					
144	- ditto -	144	- ditto.					
145	- ditto -	145	- ditto.					
146	- ditto -	146	- ditto.					
147	- ditto -	147	- ditto.					
148	- ditto -	148	- ditto.					
149	- ditto -	149	- ditto.					
150	- ditto -	150	- ditto.					
151	- ditto -	151	- ditto.					
152	- ditto -	152	- ditto.					
153	- ditto -	153	- ditto.					
154	- ditto -	–	- -	154	- ditto -	154	- ditto -	25 June 1860.
155	- ditto -	155	- ditto.					
156	- ditto -	-	- -	156	- ditto -	156	- ditto -	21 Aug. „
157	- ditto -	157	- ditto.					
158	- ditto -	–	- -	158	- ditto -	158	- ditto -	22 Aug. „
159	- ditto -	159	- ditto.					
160	- ditto -	–	- -	160	- ditto -	160	- ditto -	25 June „
161	- ditto -	–	- -	161	- ditto -	161	- ditto -	25 Feb. 1861.
162	- ditto -	162	- ditto.					
163	- ditto -	–	- -	163	- ditto -	163	- ditto -	25 June 1860.
164	- ditto -	–	- -	164	- ditto -	164	- ditto -	29 Sept. „
165	- ditto -	165	- ditto.					
166	- ditto -	166	- ditto.					
167	- ditto -	167	- ditto.					
168	- ditto -	168	- ditto.					
169	- - -	–	- -	169	- ditto -	169	- ditto -	21 Aug. „

8 April 1863.

J. Anderson,
Assistant Superintendent, Royal Gun Factories.

RETURN showing the Total Number and Nature of ARMSTRONG GUNS manufactured and supplied by the ELSWICK ORDNANCE COMPANY, up to the 31st March 1863.

Nature of Gun.	Total Number.	REMARKS.
Armstrong Gun, 300-pounder - - -	20	15 of these are outstanding.
„ „ 110-pounder - - -	261	16 - - ditto.
„ „ 70-pounder - - -	101	87 - - ditto.
„ „ 40-pounder - - -	633	39 - - ditto.
„ „ 20-pounder - - -	30	
„ „ 12-pounder - - -	92	

13 April 1863.

John Anderson,
Assistant Superintendent, Royal Gun Factories.

RETURN showing the Total Number of Royal Gun Factory Guns which have been made and issued for Service up to the 31st March 1863.

DESCRIPTION.	Total Number Made.	Number Issued for Service.	Number made but not yet Issued.	REMARKS.
6-pounder - - - -	96	86	10	Of these 10 guns, one is proved, but awaits sighting, browning, &c.; seven are not yet proved, owing to alterations in proof. *Vide* W. O. letter, 17/1/63 (73—3—3328), for which they await ammunition, and two are in advanced stages.
9-pounder - - - -	202	181	21	Of these 21 guns, three are proved, but await sighting, browning; 10 are not yet proved, owing to alterations in proof. *Vide* W. O. letter, 17/1/63 (73—3—3328), for which they await ammunition, and eight are in advanced stages.
12-pounder - - - -	625	618	7	Of these seven guns, two are proved, but await sighting, browning; one is not yet proved, owing to alterations in proof. *Vide* W. O. letter, 17/1/63 (73—3—3328), for which they await ammunition; one is ready for issue, and three are in advanced stages.
20-pounder - - - -	319	318	1	This gun is proved, but awaits sighting, browning, &c.
40-pounder, long - - -	250	183	67	Of these 67 guns, one is proved, but awaits sighting, browning, &c.; and 59 are are not yet proved, owing to alterations in proof. *Vide* W. O. letter, 17/1/63 (73—3—3328), for which they await ammunition, and seven are in advanced stages.
40-pounder, short - - -	39	–	39	Of these 39 guns were made ready to be finished as wedge or screw, and are now being completed as screw guns.
40-pounder, wedge - -	12	1	11	These 11 guns are not yet proved, owing to alterations in proof. *Vide* W. O. letter, 17/1/63 (73—3—3328), for which they await ammunition.
70-pounder - - - -	154	–	154	These 154 guns are made ready to be finished as wedge or screw guns.
110-pounders, light - - -	79	59	20	Of these 20 guns, eight are proved, but await sighting, browning, &c.; and 12 are not yet proved, owing to alterations in proof. *Vide* W. O. letter, 17/1/63 (73—3—3328), for which they await ammunition.
110-pounders, heavy - -	696	682	14	Of these 14 guns, three are proved, but await sighting, browning, &c.; two are not sighted, but are issued for proving vents, and nine are not yet proved, owing to alterations in proof. *Vide* W. O. letter, 17/1/63 (73—3—3328), for which they await ammunition.
110-pounder, proof vent - -	1	–	1	This gun is in process of manufacture.
110-pounder, wedge - -	8	–	8	These eight guns are in process of manufacture.
300-pounder - - - -	4	–	4	These four guns are not yet proved, owing to alterations in proof. *Vide* W. O. letter, 17/1/63 (73—3—3328), for which they await ammunition.

RETURN of the Total Number of Royal Gun Factory Guns, made and issued for Service, to 31 March 1863—*continued.*

DESCRIPTION.	Total Number Made.	Number Issued for Service.	Number made but not yet Issued.	REMARKS.
EXPERIMENTAL GUNS:				
Mr. *Whitworth.*				
68-pounder hooped and rifled gun.	2	2	–	
120-pounder 7" rifled gun -	1	1	–	
12-pounder brass gun - -	3	3	–	
Ordnance Select Committee.				
6·5 inch brass gun - - -	1	1	–	
Sir *William Armstrong.*				
110-pounder muzzle loading gun	2	2	–	
Mr. *Westley Richards.*				
40-pounder breech-loading gun	1	1	–	
12-pounder breech-loading gun	1	1	–	
TOTAL - - -	2,496	2,139	357	

In addition to the foregoing guns manufactured, there have been also 56 guns hooped, bored, rifled, sighted, or modified upon various plans, proposed by different persons for experimental purposes.

13 April 1863.

J. Anderson,
Assistant Superintendent, Royal Gun Factories.

Appendix, No. 21.

App. No. 21.

ABSTRACT of CORRESPONDENCE between Mr. *J. Whitworth* and the War Office from 1854 to 1860, on the Subject connected with SMALL ARMS and LARGE ORDNANCE; together with a Detail of Portion of the Expenses on account of those Experiments, referred to in Return, at page 283 of the Report of the Committee on Ordnance, dated July 1862, amounting to £. 11,292. 7. 1.

20 April 1863.

ALEX. T. TULLOH,
Director of Ordnance.

WHITWORTH CORRESPONDENCE.

1. Small Arms and General Correspondence - - - - - - - p. 382
2. Large Ordnance - - - - - - - - - - - - - 385

1. SMALL ARMS AND GENERAL CORRESPONDENCE.

1854.

Mr. Whitworth first came under the notice of the Board of Ordnance in connexion with a proposition made by him in March 1854 to undertake, on behalf of Government, a series of experiments with a view to securing, by the help of machinery, the greatest possible exactitude in the manufacture of rifle barrels.

M—164.

Mr. Whitworth renewed his proposal on the 3d April in that year, and, not being a gunmaker himself, requested that Mr. Westley Richards might be associated with him.

O—310.

The Board and the Commander in Chief agreed in the opinion that his offer should be accepted; and Lord Hardinge, in a long and interesting memorandum, dated 17th May, points out that a supply of a million muskets would be required, and that the experiments proposed would be of the greatest advantage with a view to the general adoption of the system of manufacturing barrels by machinery.

T—380.

The sanction of the Treasury was accordingly requested to an outlay of 4,000 *l.*, and was obtained on the 26th May 1854.

C—792.

It was thought desirable to associate with Mr. Whitworth an officer of artillery and an officer of the line, and Captain Jervis, R.A., Lieutenant Lutzens (20th Regiment), Mr. Westley Richards, and Mr. Whitworth were accordingly formed into a committee for the purpose of superintending the experiments.

W—4695.
S—1961.

On the 24th August 1854, Mr. Whitworth requested a remittance on account of the shed and machinery in course of preparation at Manchester.* This was ordered 2d September. The committee appointed to act with Mr. Whitworth were directed to furnish an account of the items, supported by their certificates as to their correctness, and to apply for any further advances which might be required.

This committee did nothing, Mr. Whitworth stating (13th October), that he was not ready for them, although the shed was complete.

Part of the building was blown down in a gale in that month, and had to be rebuilt, causing additional delay.

In

* The buildings were to be so erected as to be transferable to Enfield or Woolwich, or such other place as might eventually be fixed upon.

In January 1855, Captain Dixon succeeded Captain Jervis on the committee, and Captain Younghusband eventually replaced Lieutenant Lutzens. App. No. 21.

1855.

On the 19th March, Mr. Whitworth sent in his account for expenses incurred up to that time (8th March):— W—4595.

	£.	s.	d.	£.	s.	d.
1. For building				3,378	8	3
2. For rebuilding 400 yards blown down in October 1854				2,329	–	11
				5,707	9	2
3. For experiments, and apparatus and rifles connected with them	1,270	18	6			
4. For experimental machines for manufacturing rifle barrels	817	1	–			
				2,087	19	6
TOTAL				7,795	8	8
Voted in 1854–55				6,000	–	–
Excess				1,795	8	8

On the 27th March, Captain Collinson, R.E., certified the cost of the buildings (5,707 *l.* 9 *s.* 2 *d.*) to be fair and reasonable; and Captain Dixon, R.A., that of the experiments and machinery (2,087 *l.* 19 *s.* 6 *d.*) on the 7th June, with the following reservation, however, "supposing the items to be correct." C—3649.

Treasury sanction was obtained (21st June) for the excess of 1,795 *l.* 8 *s.* 8 *d.*, and the 7,795 *l.* 8 *s.* 8 *d.* was accordingly paid to Mr. Whitworth. I—388.

In the previous month (May), Mr. Whitworth had been furnished with an official introduction to Lord Cowley, with a view to facilitating his study of the methods of manufacture employed in France. O—293.

The Superintendent of the Royal Small Arms Factory having reported (7th April 1855), that Mr. Whitworth had up to that time failed to produce satisfactory machines for turning and boring rifles, it was ordered (17th and 21st September), that the machinery requisite for the production of 250 barrels a day should be procured from America at a cost of 6,500 *l.* S—5080. S—10081. S—7713.

1856.

On the 20th June 1856, Mr. Whitworth sent in an account for 5,106 *l.* 0 *s.* 2 *d.* expended between 8th March 1855 and 31st May 1856. 136 W—22.

Lieutenant Colonel Dixon and Captain Younghusband proceeded to Manchester to examine the items, and the deduction of some reduced the claim to 4,296 *l.* 18 *s.* 3 *d.* on account of small arms (16th July). 137 W—43. 137 W—48.

The Treasury were requested (12th August), to permit this amount to be charged to the vote for small arms, but demanded (22d August) further explanation. 137 W—50.

During this time Mr. Whitworth had been engaged in experiments with a view to the application of his system of rifling to large ordnance,* and on an order to supply certain machinery for the gun factory at Woolwich, stated (24th April 1856) that, if supplied, it would have to be altered in the event of the adoption of rifled cannon; and taking occasion to call attention to the experiments which he had been carrying on with ordnance, as well as small arms, during the two years previous, requested the appointment of a mixed committee to report on their results, suggesting the names of Admiral Chads and Mr. Stephenson, or Mr. Penn or Sir W. Cubitt. * *See* heading "Ordnance." 137 W—29.

Lord Panmure thought the appointment of a special committee unnecessary, but directed the select committee to form a sub-committee, to which associates were to be added. 137 W—34.

The sub-committee was eventually constituted as follows:—

Members.	*Associates.*
Lieutenant Colonel Wilmot.	Lieutenant Colonel Lefroy.
Captain Younghusband.	Captain Warlow.†
Captain Boxer.	Mr. Penn.†
Mr. Anderson.	Mr. Burton.

† Admiral Chads and Mr. Stephenson were unable to serve.

It was instructed to enter fully "into the narrative of Mr. Whitworth's proceedings," to ascertain the expenses "charged or chargeable to the public for them," and "detail the conclusions deducible from them." O 27—611.

On the 13th November 1856, the sub-committee, on visiting Manchester, recommend that Mr. Whitworth should supply three rifles ‡ to be fired in a comparative trial with three Enfield rifles. ‡ Length of barrel, 39 in.; weight of bullet, 550 grains.

On the 30th January 1857 Messrs. Whitworth recalled the attention of this office to their account of 16th July 1856 (4,296 *l.* 18 *s.* 3 *d.*) amounting (with 303 *l.* 13 *s.* for boring and rifling three 24-pounder howitzers) to 4,600 *l.* 11 *s.* 3 *d.* 1857. 136 W—33.

App. No. 21.

They were informed on the 11th March that they could not be paid until the sub-committee had reported.

79—W—7. On the 24th March it was decided by Lord Panmure that the comparative trial of the Whitworth and Enfield rifles should take place.

79—W—7. A trial took place at Hythe on the 20th April, in the presence of the Secretary of State and the Commander in Chief. It was treated as a private or preliminary one, and no report was made (diagrams only being forwarded), but it went to show that the Whitworth rifle was superior to the particular Enfield rifles then used, but they were fired with different powder and by different persons.

On the 11th June, Lord Panmure appointed a new committee, consisting of—

Sir W. Codrington (President),

81—W—18

Colonel Hay,	Lieutenant Colonel Dixon,
Colonel Gordon,	Captain Boxer,
Lieutenant Colonel Hudson,	Mr. Whitworth,

the Commander in Chief and Secretary of State being *ex officio* members.

81—W—20. On the 13th June, in obedience to instructions from Lord Panmure, Mr. Whitworth sent in a detailed narrative of his proceedings in justification of his claim to 4,600 *l.* 11 *s.* 3 *d.**

* *See* p. 383.

The first of the two items composing this sum (4,296 *l.* 18 *s.* 3 *d.* for small arms) had been referred to the Treasury for sanction in August 1856 (*see* page 383), and nothing had been done since their demand for further explanation on the 22d of the same month.

As there appeared no chance of a speedy conclusion of the committee's experiments, it was considered that payment should not be any longer delayed, and an explanatory letter

81—W—20. was addressed to the Treasury, requesting sanction (12th August). It was stated that, "so far as Mr. Whitworth was concerned the expenditure might be said to be closed, but incidental expenses might be incurred by the committee."

81—W—41. On the explanation and representations contained in this letter, the Treasury authorised the payment of the 4,600 *l.* 11 *s.* 3 *d.* on the 19th August 1857.

81—W—54. On the 26th December 25 rifles were ordered for the purposes of the committee, and it

1858. was settled (11th January) that 10 *l.* a-piece should be paid for them.

81—W—56. On the 25th February 1858, Mr. Whitworth forwarded his account for expenses

† *See* p. 393, under "Ordnance." between 31st May 1856 and 31st December 1857.† It amounted to 3,054 *l.* 5 *s.* 1 *d.* for small arms, and 442 *l.* 13 *s.* 4 *d.* for large ordnance. (The latter item was paid 27th March, together with 137 *l.* 10 *s.* for the nine-pounder gun, not included in the account).

On the 11th May, application was made to the Treasury to sanction the payment of the item for small arms (3,054 *l.* 5 *s.* 1 *d.*)

81—W—64. In reply, the Treasury quote our letter of the 12th August 1857,‡ and observe that it

‡ *See* above. appears from what was therein stated that this expenditure on Mr. Whitworth's part "must have been wholly unexpected by the Secretary of State."

On this a special committee on the accounts was appointed, consisting of Colonel Hutchinson (President of the Small Arms Committee), Captain Warlow, and Mr. Anderson, and directed to visit Manchester, go into the accounts, examine the plant, and in case of their recommending any further experiments, to prepare, in concert with Mr. Whitworth, an estimate of the cost. An opinion was expressed, in communicating this step to the Treasury, that Mr. Whitworth's proceedings ought not to be stopped pending this investigation.

81—W—65. On the 2d June the Treasury approved of this course, observing that any estimate of future outlay should be sent to them before being acted on, and that a statement of Mr. Whitworth's claims up to that date should be obtained.

In accordance with the desire expressed by the Treasury, Mr. Whitworth furnished his account down to the 31st May 1858, viz.:—

	£.	*s.*	*d.*
For rifles, &c. - - - - - - - - -	612	6	6
For large ordnance and projectiles - - - -	352	6	4
TOTAL - - - £.	964	12	10

This was from the 31st December previous.

1853. On the 8th July the special committee on the accounts reported that the amount

81—W—80. claimed was reasonable, viz., 3,054 *l.* 5 *s.* 1 *d.* for small arms (*see* above), and 964 *l.* 12 *s.* 10 *d.*

£. 3,054 5 1
964 12 10

for small arms and ordnance down to 31st May 1858 (*see* above), amounting altogether to 4,018 *l.* 17 *s.* 11 *d.*

£. 4,018 17 11

The building, machinery, and instruments, which are Government property, were estimated by this committee at 728 *l.*, and they recommended 6,000 *l.* to be taken in the

81—W—83. estimates for future experiments.

The Treasury having been informed (15th July) of this report, reply (27th July) that they are satisfied by this careful investigation that the 4,018 *l.* 7 *s.* 11 *d.* should be at once paid, and that 6,000 *l.* might properly be taken in the estimates for 1859-60 to meet future outlay.

81—W—66. The 4,018 *l.* 17 *s.* 11 *d.* was paid Mr. Whitworth on the 6th August.

On the 5th June Colonel Hutchinson (President of the Small Arms Committee) had succeeded Sir W. Codrington as president of the committee on the two arms.

Being

Being of opinion that the superior precision of the Whitworth rifle was not owing to the different mode of rifling alone, but in a great degree to the smaller diameter of the bore, the Whitworth and Enfield Rifle Committee recommended (17th June 1858) that 10 Enfield rifles of a reduced bore should be manufactured, with a view to a more satisfactory comparison of the two weapons. App. No. 21. 81—W—72.

This was eventually approved (28th June) on the understanding that this was not to interfere with the main object of inquiry before the committee, viz., the comparative excellence of the two existing arms. The Commission were so informed (24th June).

Shortly afterwards a disagreement arose between Mr. Whitworth and the majority of the committee as to the powder to be used with his rifles, he insisting on a special powder, so that each weapon might be enabled to do its best, and they requiring that both rifles should be fired under the same conditions, and with the service powder. 81—Gen. No.—89.

After a report had been several times called for, one was furnished, and is now in the printer's hands; but only two of the members entirely agreed in it, the rest appending their views in separate papers. The general opinion was that no grounds for a satisfactory conclusion had as yet been reached.

The committee was dissolved (24th March 1859), General Peel reserving for further consideration the question of any ulterior steps which may be judged advisable. 81—W—140.

2. Large Ordnance.

[*N. B.* The pieces marked* have been tried and reported on, all favourably, with the exception of the two 32-pounders and the 68-pounder, which burst.]

The following are the guns supplied at various times by Mr. Whitworth, and paid for by the public:—

One 6-pounder - - - -	ordered on	24 December 1855.
* One 24-pounder howitzer - -	„	24 January 1856.
Two ditto - - - -	„	18 April 1856.
* One 12-pounder gun - - -	„	24 June 1856.
* One 9-pounder and projectiles -	„	5 September 1857.
* One 6-pounder - - - -	„	16 October 1857.
* One 32-pounder - - - -	„	16 October 1857.
* One 32-pounder - - - -	„	29 May 1858.
* One 68-pounder - - - -	„	3 June 1858.
10 Total.		

80—W—22. 80—W—31. 80—W—89. 79—W—30.

I have failed in tracing the papers on which Mr. Whitworth was first authorised to apply his system of rifling to large guns, but it appears from his accounts and other papers that the first gun supplied by him, was the 6-pounder ordered in December 1855. This is apparently still at Shoeburyness untried.

On the 2d February 1858, the Admiralty forwarded a report of the trial of the 24-pounder howitzer on board the "Excellent." The practice was at a ship's side below the water line, and was so successful as to cause an order to be given for the preparation of 15 shells of the same shape to be fitted with Boxer's fuzes. 1858.

On the 24th April, the further trial took place, but the fuzes failed to explode below the surface of the water. It was referred to Captain Boxer to devise a fuze for the purpose, and ordered that a portion of the next supply of shells should be fitted with Moorsom's fuze. 80—W—67. 80—W—85.

On the 5th May 1858, Mr. Whitworth submitted models of a breech-loading rifled, 32-pounder gun, and 8-inch mortar, with a receding breech, and an arrangement for the independent recoil of the piece.† He estimated the cost at 140 *l.* for the gun, and 134 *l.* for the mortar. 80—W—99. 80—W—86.

This was immediately authorised, Sir B. Hawes observing that "the preparation of such guns should not be delayed, and that it was not on such services as these that there should be any delay in encountering expense." Treasury sanction was not required, as the expense was covered by the vote.‡ 80—W—93.

On the 14th May, the Ordnance Select Committee report that Mr. Whitworth's 32-pounder (ordered October 1857, and delivered February 1858) had burst at the fourth round.

Mr. Whitworth stated that this was caused by the gun having been fired at too high an elevation, and with too great a charge. The elevation, however, was only 15°, and the charge 18 lbs., the gun being nearly two inches thicker than the ordinary 32-pounder, which is fired with 10 lbs. 80—W—95.

At Mr. Whitworth's request, he was granted another 32-pounder block (58 cwt.), to be bored and rifled as he proposed at his own expense, with a view to determining whether this angular form of rifling was or was not unsafe for iron guns. 29 May 1858. 80—W—89.

In

* [Besides these, a 32-pounder breech-loading gun, and an 8-inch mortar were ordered (5th May 1858), but have not been delivered.]

† These pieces, with the exception of the breech, were to be of brass.

‡ This gun and this mortar have not yet been delivered.

App. No. 21.
79—W—29. In consequence of a suggestion from the Admiralty, that Mr. Whitworth should be permitted to bore and rifle a 68-pounder (95 cwt.) for experiments at Portsmouth, he was furnished (3d June 1858) with a block to be bored and rifled at his own expense.

This was subsequently authorised to be done at the public expense (150 *l.*), and Treasury sanction obtained 18th June 1858.

79—W—30. This 68-pounder gun was tried on board the "Excellent" on the 8th October 1858,
79—W—106. in the presence of the Rifled Cannon Committee, into whose hands the experiments at
79—W—46. 49. Shoeburyness with these guns had by this time passed. The gun burst at the second round with great violence.

A controversy ensued about the cause of the accident. Mr. Whitworth asserted that it was caused by the air admitted behind the charge by too small a cartridge; Captain Hewlett and the Rifled Cannon Committee, to whom half of the broken shot was sent, believed it to have jammed in the bore; while Mr. Anderson was of opinion that the iron was too weak to resist the great centrifugal force exerted by a projectile rotating with such rapidity.

79—W—64. The day after the Committee's report, the 32-pounder was tried at Shoeburyness, and also burst at the second round. (Elevation 10°, charge 5 lbs., as fixed by Mr. Whitworth.)

31—W—135. A report unfavourable to any further experiments with Mr. Whitworth's cast-iron guns had already been made by the committee on rifled cannon in October, and General Peel
79—W—63. now directed that Mr. Whitworth should be informed "that as all three of his cast-iron polygonally bored guns had burst at an early stage of the experiments, he had decided on discontinuing experiments with this form of rifled cannon."

Mr. Whitworth was so informed on the 28th December 1858.

[*N. B.* It appears from the report on the Armstrong gun that all Mr. Whitworth's guns had a strong tendency to throw to the right, a defect which it was supposed would extend to the brass guns.]

In the meantime the 9-pounder brass gun had been tried on the 31st August by the select committee. The report of the practice, which was dated the 17th October, was sent to the Rifled Cannon Committee on the 23d October. At the request of the latter, an order was given to Mr. Whitworth for 100 shot and 100 shells, with a view to a further trial of this gun. No such trial has as yet taken place.

1859. On the 10th March 1859, Mr. Whitworth stated that he had been engaged since the
80—W—151. bursting of his three cast-iron guns in the construction, at his own risk and cost, of two other guns, from which he anticipates every success. I have reason to believe, though it is not so stated in the papers, that they are of wrought iron with a bore of homogeneous metal. Before completing them, he expressed his desire to make some experiments with his brass guns (four in number) now remaining at Shoeburyness.

80—W—156. These experiments were sanctioned at his own expense (17th March), but on a subsequent paper, General Peel, on Sir B. Hawes's representation that Mr. Whitworth well deserved this consideration, authorized the supply of the necessary ammunition for this purpose at the public expense. A sufficient quantity of projectiles adapted to these guns remain in Colonel Mitchell's charge since the last experiments with them.

AMOUNT Paid to Mr. *Whitworth* on account of—

		RIFLE EXPERIMENTS.	LARGE ORDNANCE.
To 8 March 1855:	£. s. d.	£. s. d.	£. s. d.
Buildings, &c. - - -	5,707 9 2		
Rifle experiments, &c. - -	2,087 19 6		
		7,795 8 8	
		Paid June 1855.	
8 March 1855 to 31 May 1856 - - - -		4,296 18 3	303 13 –
		Paid August 1857.	
			442 13 –
			137 10 –
31 May 1856 to 31 December 1857 - - -		3,054 5 1	580 3 –
			Paid March 1858.
31 December 1857 to 31 May 1858 - - -		612 6 6	352 6 4
		3,666 11 7	
Paid August 1858 - - -		£. 4,018. 17. 11.	

WHITWORTH CORRESPONDENCE.

App. No. 21.

1. Small Arms and General Correspondence - - - - - - - - p. 387
2. Breech-loading Rifled Ordnance - - - - - - - - - - p. 389

1. Small Arms and General Correspondence.

1859.

It will be necessary, before continuing the history of Mr. Whitworth's dealings with the Government in relation to small arms, to give a general outline of the results of the experiments made, and the conclusions arrived at, by the Whitworth and Enfield Rifle Committee. The Committee were not unanimous in their report, but the points of difference will be shown.

Twenty-five rifles had been ordered of Mr. Whitworth in December 1857, but the summer of 1858 passed without the arms being delivered, so that a trial of "fouling" (for which a hot dry atmosphere is a necessary condition) did not take place. It is explained in the report (paragraph 18) that Mr. Whitworth had withdrawn from the Committee, owing to a disagreement with the majority of the Committee as to the powder to be used with his rifles—he insisting on a special powder best suited to his rifle, the Committee deeming it necessary, without adopting an individual opinion, to make experiments under unfavourable as well as favourable conditions, the former being generally considered the rule in warlike operations.

In the experiments for accuracy, different "makes" of Government F. G. powder being employed, the Whitworth had proved itself superior to the Enfield rifle. Ten rifles only were used, Mr. Whitworth having withdrawn the other 15. The barrels of these arms were heavier than those of the Enfields; and the Committee remarked that no true comparison could be made between the polygonal and grooved systems of rifling as long as the diameter of bore was different. Ten Enfield rifles of reduced bore were then made, and on consideration it was thought that the grooved system had some advantages over the other. The Committee further observed that, in order to test effectually the relative merits of the two systems, experiments should be made with arms on the polygonal system, of an increased diameter.

Experiments for penetration could not be proceeded with, because Mr. Whitworth had not supplied the hardened bullets ordered of him.

"There can be no doubt that the combined arrangements adopted by Mr. Whitworth as regards the diameter of bore, length of bullet, and pitch of rifling, have, *under certain conditions*, shown a great superiority in the accuracy of shooting over those carried out in the Enfield pattern, 1853." (Printed report, paragraph 61.) It remained, however, to be proved whether, after providing for other necessary conditions, any advantage in this respect would remain. The experiments with rifles with reduced bore and increased pitch, and grooved according to the Enfield system, had given such satisfactory results as to warrant the Committee in recommending the provision of a supply of 25 for further experiments.

The Committee were unable to report as to the probable cost, and facilities for obtaining large supplies of Whitworth rifles, Mr. Whitworth having failed to furnish the information required of him.

They concluded by saying that they were not yet in a position to recommend any change in the system then in use.

The report was signed, with the following reservations:—

Major-General Hutchinson (the President) expressed his opinion that the polygonal system of rifling was the best, and considered the question narrowed to one of expense, and facility of supply.

Major-General Hay, in a memorandum attached to the report, enumerated the great advantages which, in his experience, he had found the Whitworth rifle to possess over the Enfield, as regards range, accuracy, penetration, strength, and weight (being less).

Mr. Whitworth dissented from the report on the ground (also pointed out by General Hay) that no notice had been taken of the experiments which were previously conducted by the Committee under the presidency of General Codrington, and which he contended, proved the superiority of his rifle on all those points upon which the Committee were called upon to decide.

Colonels Gordon and Dixon concurred in the report as far as it went, but expressed an opinion that, under similar and equal circumstances, the Enfield had shown a superiority over the Whitworth as regards accuracy of fire and horizontal trajectory.

Colonel Hudson and Captain Boxer agreed to the report.

The report was dated 1st January 1859, and the Committee was dissolved on the 24th March.

Early in April General Hutchinson urged the importance of ordering arms at once, if it was intended to make experiments for ascertaining "fouling," during the ensuing summer.

81—W—141.

App. No. 21. summer. Mr. Whitworth was accordingly written to, and in reply (21st April) stated that the 25 arms ordered in 1857 were available for this experiment. Bullets were also ordered on the 28th May.

143. On the 18th June 1859 the whole subject was handed over to the new Ordnance Select Committee, who immediately recommended that the 10 Whitworth rifles which were tried at Hythe under the directions of the Special Committee should be sent to Mr. Whitworth for examination and repair, if necessary; and also that 10 Enfield rifles of reduced bore and cut down to 36 inches (the length of the Whitworth rifle) should be ordered. This was done on the 18th July 1859. On the 13th October Mr. Whitworth was requested to furnish a sample of ammunition to make a supply for the trial of these arms. In reply he declined to enter into any further trials beyond those necessary to decide the relative merits of the two rifles. It appeared, he said, that it was intended to try the three-grooved rifle with a reduced bore and quick turn. These conditions he considered as parts of his system. This he thought was a departure from the original programme—in fact it would be a trial of parts of his system against one another. He also complained of the opposition he had met with from those "officially connected with the present manufacture."

151.

152.

169.

Meanwhile Mr. Whitworth, not having forwarded his rifles, the Ordnance Select Committee were compelled to postpone the experiments for "fouling" till the summer of 1860; but they considered that the comparison of the two descriptions of arms in other particulars might proceed; and Mr. Whitworth was therefore again called upon to furnish the 25 rifles, 25th November.

81—W—170. In reply, he stated that if further experiments were decided upon, he would wish to send his rifles in charge of his own men, and he would be prepared to meet the Committee on due notice being given him.

On the 21st November, Mr. Whitworth wrote to say that he was prepared to state the cost of supplying his arm. The rifle company he had established would undertake to arm a regiment of 1,000 or 1,200 men, at 10*l.* each. He observed that although he had taken out a patent for his improvements, "it was always distinctly understood that his rifle was at the full disposal of the Government." The O. S. Committee were referred to, and reported that they were not prepared to recommend the supply of such an expensive weapon. It also appears that in conversation with Colonel St. George, Mr. Whitworth had asked whether, in the event of supplying these arms, the gauge would be an established one in the service. Mr. Herbert decided that "we cannot undertake to run the risk of introducing another gauge and another ammunition into the service till the change promises a greater amount of advantage than this offer, the price of which places it beyond the highest value of a military weapon."—13th December. On the 20th December, Mr. Whitworth was informed that Mr. Herbert was not at present prepared to accept his offer

81—W—175. to arm a regiment. He was also told that the Committee were ready to pursue the experiments, and he was requested to send his arms as soon as possible, there being no objection to his men coming too.

1860. But the arms were not sent, and at the end of January 1860, in conversation with Colonel St. George, Mr. Whitworth explained that he had been giving his attention to artillery, and was not yet prepared to supply the 25 rifles. He was also, he said, making a rifle with the service bore, which he was desirous of submitting at the same time.

On the 9th March 1860, Colonel St. George directed attention to a letter from Mr. Whitworth to the late Special Committee, dated 6th November 1858,* in which he stated that the machinery at Enfield could be adapted to the production of hexagonal barrels of the bore and turn recommended by him; renewing the offer of his assistance, made in 1854, and suggesting an additional outlay of 5*s.* per barrel to be expended in bestowing more care in their manufacture. A discussion ensued, in which Colonel Dixon took part, and it was shown,—

1st. That Mr. Whitworth declined further competition with the Enfield rifle.

2d. That as far as experiments had gone, the Enfield *small bore* rifle had proved superior to the Whitworth rifle; and—

3d. That upwards of 12,500*l.* had been paid to Mr. Whitworth for his experiments in connection with small arms, for which the public had as yet received no equivalent.

The question was put thus by Mr. Herbert: "There is no doubt that the Whitworth homogeneous rifle is a better weapon than the Enfield. The question is, will the increased strength and durability of the material prove sufficiently great to justify paying three times the price for it. This can only be tested by time. But what I want to see is the trial of an ordinary Enfield reduced bore, and a Whitworth made of our Enfield metal, and that will show what the peculiar form of rifling is worth. This, I imagine, Colonel

81—W—188. Dixon could do."—19th March.

192. Mr. Whitworth, on being asked, agreed to make 10 rifles of his pattern and gauge, of the Enfield metal, and the order was given on the 10th April. Subsequently the order was amended on the application of Mr. Whitworth; first, he desired to have the Enfield barrels roughly bored and turned, and then he applied to have them stocked and finished to a plain bore of ·448. This was agreed to, 26th May.

In reply to an inquiry from the War Office, Colonel Dixon stated, in a letter dated 17th July,

* Page 12. Printed papers.

17th July, that he was making these barrels of a reduced external diameter, in order that the weight, when completed before rifling, might be nearer to that of the Enfield barrel than it would otherwise be. It was then decided that 10 more should be prepared for Mr. Whitworth of exactly the same external diameter as the long Enfield rifle. This order was given 26th July. App. No. 21.

The arms were reported by Mr. Whitworth as ready on the 6th September, and they were delivered at the Tower on the 17th. Meanwhile, Mr. Herbert had decided that five of each description should go to Hythe, and the remaining five of each to the Ordnance Select Committee. The Committee were informed of this, and 10 Enfield rifles of reduced bore were ordered for comparative trial with Mr. Whitworth's arms; 13th September. 205.

The question was then raised by Colonel Dixon as to the ammunition to be used, in order that he might be guided in determining the exact bore for his rifles. He also inquired as to the twist and grooving to be employed. By a letter of the 24th October 1860, he has been informed that the twist and grooving are left to him to decide upon, and he will receive a sample of ammunition from the Committee, for his guidance in fixing the bore. 213. 221.

2. Breech-loading Rifled Ordnance.

On the 26th March 1860, Mr. Whitworth was informed that Mr. Herbert's attention had been drawn to the reports which had been made public, of the results of certain experiments made by Mr. Whitworth with his gun; and that he considered it important that a thorough comparative trial should be made with guns of his construction, and those made by Sir William Armstrong. A general sketch of the proposed trials was submitted to Mr. Whitworth for his concurrence. In reply, he stated, that although his guns would be tried under manifest disadvantages, he was willing to agree to the experiments; and he proposed certain conditions. He was promised, in reply, a programme, as soon as it was drawn up; and it was explained to him that he was in error in supposing that his guns would be tried under any disadvantages at all. 80—W—228. 232.

The programme was then drawn up by the Ordnance Select Committee, for the experiments with field guns, and was forwarded to Mr. Whitworth, for his concurrence, on the 27th April, and returned by him on the 12th May, with alterations and additions, to many of which the Committee found it impossible to agree. Mr. Whitworth had stipulated that each class of the experiments should be reported on as they were concluded. The Committee pointed out the inconvenience of such an arrangement, and contended that Class II. (which included those trials which required time to carry out), should be finished before any report was made. The question being as to the relative value of the two guns for general service, no decision could be arrived at on the results of the experiments under Class I. alone.* They also strongly objected to Mr. Whitworth working his own guns; and explained that no proper comparison could be made as to the facility of laying and working the guns, unless both were worked by artillerymen; these men might be previously instructed if thought necessary. Certain other minor objections were also urged by the Committee, and an amended programme was eventually sent to Mr. Whitworth on the 9th June. 239. 80—W—274.

On the 7th June, a programme for the heavy guns was submitted by the Committee, but it was not discussed, owing to the differences arising out of the other programme.

Mr. Whitworth's answer to the Committee's objections, dated 14th June, was accidentally mislaid until the 4th August. He states that he felt compelled to stipulate that his guns should be worked by his own men, and remain under his control, and also that a portion, at least, of the experiments should be proceeded with, and completed within a fixed and reasonably limited time, and a report of the results made on their conclusion. As the Committee have refused to accede to these conditions, he has no other course but to decline to assent to the trials proceeding on the terms proposed. 306.

Meanwhile, in June—July, the question of making a semi-official trial at Southport in the presence of Government officers, was discussed and agreed to. It was decided that this trial could only be of a preliminary nature, and serve to guide the Secretary of State in determining whether any guns should be purchased. Should guns be subsequently bought, trials of a more searching character would have to be made before any decision could be come to as to the adoption of the system into the service.

The experiment took place on the 25th July. Colonel St. George attended on the part of the War Office; Colonel Bingham, D.A.G., R.A., represented the Horse Guards; and Commander Herbert represented the Admiralty. The powder and fuses were supplied by the War Office, and the result of the experiments was considered sufficiently favourable to warrant the purchase of an 80-pounder and a 12-pounder, in order to make further trials. 80—W—303.

A price was agreed upon (1,000*l.* and 170*l.*, respectively), and the guns were ordered to be sent to Woolwich on the 27th August.†

29 October 1860.

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* Class I. was to include accuracy, range, penetration, ricochet, rapid firing, convenience of working, recoil. Class II., destructive effect, effect of exposure, liability to be disabled, &c.

† Received 13th November. They are to be handed over to the Ordnance Select Committee. 80—W—359.

App. No. 21.

(3246.)

Manchester, 19 March 1855.

The Honourable Board of Ordnance to *Joseph Whitworth & Co.*

Dr. No. 1 Account.

Building Rifle Shed, 517 Yards long, 22 Feet wide; Outside Measurement, Walls, 22 feet high, with Firing-house at one end, Offices, &c.:	£.	s.	d.
Excavating and levelling	114	4	7
Bricks	944	1	7
Bricklayers	408	5	–
Builders' contract for roof, &c,	1,242	12	10
Lime	92	10	6
(*See* Remark in 3244.)			
Sand	70	8	–
Gravel and materials for road and foundations	77	4	6
Drain pipes and drains	27	17	8
Iron gutters, spouts and brackets	82	8	–
Wood pavement	38	13	6
Calico and glass for windows	67	2	8
Gas fittings	27	14	4
Ironmongery, gas stoves, pipes, and matting	32	11	4
Forgings, iron, 23 lbs.	–	9	10
Articles from store	34	11	8
Joiners and plumbers 392 hours	15	–	6
Draughtsmen and foremen 2,296¾ „	102	11	9
£.	3,378	8	3

(3247.)

Manchester, 19 March 1855.

The Honourable Board of Ordnance to *Joseph Whitworth & Co.*

Dr. No. 2 Account.

Rebuilding Rifle Shed:—	£.	s.	d.
Bricks	81	15	8
Bricklayers	412	17	6
Slaters	80	11	4
Labourers	181	12	2
Cartage	120	15	2
Grinding mortar and hire of mortar mill	57	–	1
Lime and cement	76	1	8
(*See* Remark on 3422.)			
Sand	42	–	–
Timber	319	1	8
Gravel and materials for road and foundation	66	18	6
Slates, tiles, &c.	212	19	–
Coals, coke, and cannel	17	12	8
Ironmongery, nails, &c.	27	15	–
Castings, iron girdings, &c. 168 *cwt.* 3 *qrs.* 18 *lbs.*	108	13	7
Forgings, iron 2,533 *lbs.*	54	12	4
Articles from store	51	6	6
Mechanics and machines 75 hours	4	13	1
Joiners and pattern makers 7,977¼ „	306	5	6
Draughtsmen and foremen 2,192 „	106	9	6
£.	2,329	–	11

App. No. 21.

(3245.)

Manchester, 19 March 1855.

The Honourable Board of Ordnance to *Joseph Whitworth & Co.*

Dr. No. 3 Account.

Rifle Experiments, Two Firing Machines, New Rifles, and Targets, up to 8 March 1855, inclusive:		£.	s.	d.
Iron castings, including beds, slides, &c.	264 *cwts.* 0 *qrs.* 1 *lb.*	184	16	8
Wrought iron forgings	2,732 *lbs.*	58	18	2
Steel forgings	181¼ *lbs.*	10	8	5
Articles from store		17	5	2
Scale-beam and weights		23	14	–
Gas rent		7	8	9
Coals		10	2	10
Mechanics and machines	6,538½ hours	480	–	8
Pattern-makers, joiners, &c.	1,884½ „	79	4	10
Labourers	3,600 „	69	–	–
Assistants engaged in experiments; draughtsmen and foremen	3,290¾ „	329	19	–
(*See* Remark on 3244.)				
	£.	1,270	18	6

(3244.)

Manchester, 19 March 1855.

The Honourable Board of Ordnance to *Joseph Whitworth & Co.*

Dr. No. 4 Account.

New Machinery for Boring, Turning, and Rifling Barrels, up to 8th March 1855, inclusive:	*Cwts. qrs. lbs.*	£.	s.	d.
Iron castings, including wheels, pinions, pulleys, &c.	101 0 25	81	14	5
Brass castings	0 3 11½	8	4	9
Iron forgings	10 2 26	24	5	4
Articles from store		7	6	3
Mechanics and machines	7,272¾ hours	557	5	9
Pattern makers and joiners	514 „	22	3	3
Draughtsmen and foremen	1,262½ „	116	1	3
	£.	817	1	–

See 13,573 for final payment in respect of this service, sanctioned by Treasury Letter of 22d August 1857. 81—W—41.

App. No. 21.

Small Arms Account.

Chorlton-street, Portland-street, Manchester,
25 February 1858.

The Honourable Board of Ordnance to *Joseph Whitworth & Co.*

Dr.

For Rifle Experiments and Machinery for Boring, Turning and Rifling Barrels.		£.	s.	d.	£.	s.	d.
29th May to 30th September 1856:	*Cwt. qrs. lbs.*						
Iron castings	20 1 7	19	2	7			
Brass castings	0 0 13¾	1	3	9			
Iron and steel forgings	3 0 23¼	18	5	6			
Lead and tin	8 2 15¾	16	2	7			
Stores		1	14	4			
Mechanics and machines	7,127¾ hours	422	1	9			
Labourers at shed		2	1	4			
Timber		1	1	–			
Plumbing and glazing		3	16	–			
Gunpowder		3	7	2			
Gas		13	10	–			
Lithographing		3	4	–			
Steel		1	13	3			
Oil sheet		–	18	9			
Sundries		2	5	9			
					510	7	9
1st October to 31st December 1856:	*Cwt. qrs. lbs.*						
Iron castings	51 2 22	42	10	10			
Brass castings	0 2 2½	5	–	11			
Iron and steel forgings	7 3 25¼	37	6	5			
Lead and tin	3 1 3	6	2	4			
Stores		1	3	4			
Mechanics and machines	9,935¼ hours	623	8	9			
Timber		12	12	–			
Philosophical instruments		25	17	–			
Gas		6	2	7			
Gunpowder		1	13	7			
Sundries (including men's expenses to London)		22	14	2			
Coals (1st claim)		3	18	9			
					788	10	8
1st January to 31st March 1857:	*Cwt. qrs. lbs.*						
Iron castings	79 2 20	52	5	8			
Brass castings	0 0 1	–	1	9			
Iron and steel forgings	7 0 4¼	34	4	–			
Lead and tin	1 0 21½	2	4	6			
Stores		–	11	8			
Mechanics and machines	7,956 hours	479	14	11			
Timber		3	3	–			
Gas		6	3	4			
Gunpowder		1	13	7			
Musket stocks		3	–	–			
Steel for barrels		2	9	10			
Oil sheet		2	15	9			
Sundries		–	9	–			
					588	17	–
1st April to 30th June 1857:	*Cwt. qrs. lbs.*						
Iron castings	19 2 1½	19	11	7			
Brass castings	0 0 13¾	1	3	8			
Iron and steel forgings	5 1 20¾	27	4	1			
Lead and tin	3 3 16¼	7	5	5			
Stores		1	15	9			
Mechanics and machines	6,325¾ hours	378	18	–			
Timber		5	11	3			
Gas		14	14	10			
Philosophical instruments		8	2	–			
Taxes		12	1	9			
Coals		4	6	4			
Gunpowder		2	11	11			
Sundries (including men's expenses to Hythe)		15	15	7			
					499	2	2
Carried forward				£.	2,386	17	7

App. No. 21.

Dr.			£.	s.	d.
	Brought forward - - -	- -			2,386 17 7
1st July to 30th September 1857:	*Cwt. qrs. lbs.*	£. s. d.			
Iron castings - - - - -	3 1 1	3 7 6			
Brass castings - - - - -	0 0 19¾	1 14 –			
Iron and steel forgings - - -	5 3 15¼	27 8 2			
Lead and tin - - - - -	4 0 3½	7 10 6			
Store - - - - - -	- - -	6 – 11			
Mechanics and machines - - -	5,777½ hours	321 1 10			
Timber - - - - - - -	- - -	4 5 4			
Gas - - - - - - - -	- - -	11 9 3			
Taxes - - - - - - -	- - -	5 6 8			
Oil sheet - - - - - -	- - -	– 15 7			
Sundries (including men's expenses to London) - -		45 19 2			
					434 18 11
1st October to 31st December 1857:	*Cwt. qrs. lbs.*				
Iron and steel forgings - - -	1 0 11¾	6 3 6			
Lead and tin - - - - -	0 3 13	1 12 4			
Stores - - - - - -	- - -	0– 13 –			
Mechanics and machines - - -	3,884½ hours	2 7 19 3			
Timber - - - - - - -	- - -	1 1 –			
Oil sheet - - - - - -	- - -	3 19 –			
Gunpowder - - - - - -	- - -	1 13 7			
Coals - - - - - - -	- - -	5 14 6			
Gas - - - - - - - -	- - -	– 15 9			
Taxes - - - - - - -	- - -	2 8 4			
Sundries - - - - - - -	- - -	– 8 4			
					232 8 7
		£.			3,054 5 1

Large Ordnance Account.

Chorlton-street, Portland-street, Manchester,
25 February 1858.

The Honourable Board of Ordnance to *Joseph Whitworth & Co.*

Dr.			£.	s.	d.
For Work on Large Ordnance and Projectiles.					
29th May to 30th September 1856:		£. s. d.			
Mechanics and machines - - -	- 164 hours	11 15 1			
Carriage - - - - - -	- - -	5 7 5			
					17 2 6
1st October to 31st December 1856:	*Cwts. qrs. lbs.*				
Iron castings - - - - -	16 1 25	15 3 4			
Forgings - - - - - -	0 1 18¾	1 15 10			
Mechanics and machines - - -	1,819½ hours	123 9 1			
Timber - - - - - - -	- - -	– 10 6			
Carriage - - - - - -	- - -	4 7 10			
					145 6 7
1st October to 31st December 1857:	*Cwts. qrs. lbs.*				
Iron castings - - - - -	62 3 17	47 1 6			
Forgings - - - - - -	7 1 17¼	35 3 1			
Mechanics and machines - - -	3,011¾ hours	197 19 8			
					280 4
		£.			442 13 4

Appendix, No. 22.

App. No. 22. PAPERS delivered in by Captain *H. W. Gordon*, C.B., 20 April 1863.

(A.)

(In part reply to Query 938.)

MONTHLY REPORT of the Inspection and Final Proof of ARMSTRONG GUNS Manufactured at the Royal Gun Factories, and tested by the Inspector of Artillery during the Month of June 1860.

Date of Proof.	Service or Battery.	Number of Guns.	Number of Rounds per Gun.	Charge in Lbs.	Range in Yards.	——
5 June 1860	No. 4 Battery, 4th Brigade - -	6	10	1¾	1430	
5 „ „	No. 6 „ 4th „ - -	6	10	1¾	1430	
6 „ „	No. 5 „ 8th „ - -	6	10	1¾	1350	
12 „ „	No. 9 „ R. H. „ - -	6	10	1¾	1330	
12 „ „	Reserve guns - - - - -	2	10	1¾	1330	These guns kept in reserve, to replace defective guns.
18 „ „	No. 1 Battery, 9th Brigade - -	6	10	1¾	1330	
26 „ „	No. 3 „ 4th „ - -	6	10	1¾	1400	

We do hereby certify that the foregoing ordnance have been finally proved as above, in accordance with War Office Order, dated 19th May 1860; that they were carefully examined after firing, and are in every respect fit for Her Majesty's service.

(signed) *A. Noble*, Captain R.A.,
Assistant Inspector of Artillery,
July 1860.

(signed) *P. M'Kinlay*, Proof Master,
July 1860.

Right Hon. the Secretary of State for War,
&c. &c. &c.

(B.)

(In reply to Query 935.)

REPORT of the INSPECTION and PROOF of ARMSTRONG GUNS at the Inspector of Artillery Department, during the Month of June 1860, for Her Majesty's Service.

By whom Supplied.	Date of Proof.	Nature.	TOTAL. Inspected. 1st.	2d.	Total.	Reserved for further trial.	Condemned.	Received.	REMARKS.
Elswick Ordnance Company.	5 June 1860	40-pr. Gun, rifled	7	–	7	1	1	5	
Royal Gun Factories -	18 June 1860	12-pr. ditto - -	–	3	3	–	–	3	These guns were previously reported as reserved for further proof trial; they have since been repaired, and are now fit for Her Majesty's Service.
		TOTAL - - -	7	3	10	1	1	8	

We do hereby certify that the foregoing Ordnance have been inspected, and those in the receivable column have been proved in the presence of the Proof-Master, under my superintendence, and are fit for Her Majesty's Service.

(signed) *A. Noble*, Capt. R.A.,
Assistant Inspector of Artillery,
July 1860.

(signed) *P. M'Kinlay*, Proof Master,
July 1860.

Right Honourable the Secretary of State for War,
&c. &c. &c.

(C.)

(Part of reply to Query 952.)

App. No. 22.

OFFICE OF INSPECTOR OF ARTILLERY, 25 November 1862.

MEMORANDUM of EXAMINATION of 40-pounder, No. 15, R. G. F. (before issued).

EXPLANATION.—The letters R. L. UP. D. denote the position of the flaws in the bore as shown on the diagram, which represents the muzzle of the gun; the intermediate position being described as right of up, right of down, left of down, &c., &c. All distances are measured from the muzzle, except flaws in the powder chamber, which are measured from the breech.

Slight flaws in bore at 4 L. of UP.; 13¾ R. of D., 17 R. of UP., to R. of D.; 22 L. of UP.; 28¾ L. of D., 38¾ L. of UP. to UP.; 44¼ R. of UP., 57¼ R. of UP.; 75¼ L. of D., 78¾ R. of UP. Slight flaw in powder chamber at 7¼ L. of UP., and R. of D., 11 L. "A." tube coiled. Defect in right trunnion.

H. Dyer, Captain Royal Artillery,
Assistant Inspector of Artillery.

N.B.—This return to be preserved and returned into store with the gun. The number of rounds fired, and remarks of any examination that may have been made of the gun while on service, to be filled in on the other side of this sheet.

(D.)

(Part of reply to Query 952.)

OFFICE OF INSPECTOR OF ARTILLERY, 25 November 1862.

MEMORANDUM of EXAMINATION of 12-pounder, S. S., No. 117, R. G. F. (before issued).

EXPLANATION.—The letters R. L. UP. D. denote the position of the flaws in the bore as shown on the diagram, which represents the muzzle of the gun; the intermediate position being described as right of up, right of down, left of down, &c., &c. All distances are measured from the muzzle, except flaws in the powder chamber, which are measured from the breech.

Slight flaws in bore at 6½ R. of UP.; 15½ R. of D., on lands 17″ to 23″ R.; 19 to 25 D., 38″ D.; 39½ L. of UP. Powder chamber, slight flaw R. of UP. Interior lining straight.

H. Dyer, Captain Royal Artillery,
Assistant Inspector of Artillery.

N.B.—This return to be preserved and returned into store with the gun. The number of rounds fired, and remarks of any examination that may have been made of the gun while on service, to be filled in on the other side of this sheet.

(E.)

(Reply to Query 995.)

ROYAL GUN FACTORIES, 26th March 1863.

MEMORANDUM OF EXAMINATION of L.S. 12-pounder, No. 234, R. G. F. (before issued).

EXPLANATION.—The letters R. L. UP. D. denote the position of the flaws in the bore as shown on the diagram, which represents the muzzle of the gun; the intermediate position being described as right of up, right of down, left of down, &c., &c. All distances are measured from the muzzle, except flaws in the powder chamber, which are measured from the breech.

Slight flaw in bore 39″ R. 17″ UP.
"A." tube coiled.
Bushed 15 125″ from vent seat.

J. Anderson, Assistant Superintendent,
Royal Gun Factories.

N.B.—This return to be preserved and returned into store with the gun. The number of rounds fired, and remarks of any examination that may have been made of the gun while on service, to be filled in on the other side of this sheet.

App. No. 22.

No. 11,601. (F.)

(In reply to Queries 938 and 1018.)

OFFICE OF INSPECTOR OF ARTILLERY, 14th February 1861.

THE undermentioned Ordnance have been selected for the following Stations and Services as follows quoted:

Station and Service.	Date of Order.	Description of Ordnance.	No.	Remarks.
5th Battery, 9th Brigade	21st Dec. 1860 A. 3 / 38	12-pr., 8 cwt., Armstrong	6	(D. 2,414)—Superintendent R. G. Factory.—Will you note and return? *H. W. Gordon.* 15/2/61. P.S.S.
6th Battery, 9th Brigade		12-pr., 8 cwt. Armstrong	6	

The P.M. Storekeeper, Royal Arsenal.

J. Lyons, Captain, Assistant Inspector of Artillery.

Station.	Nature.	No.	Register.
5th Battery	12-pr. 8 cwt.	160	R. G. F.
		168	"
		199	"
		259	"
		262	"
		263	"
6th Battery	12-pr., 8 cwt.	181	"
		304	"
		307	"
		314	"
		315	"
		318	"

No. 5046.
No. 11,906. (G.)

(In reply to Query 949.)

OFFICE OF INSPECTOR OF ARTILLERY, 23d February 1861.

THE undermentioned Ordnance have been selected for the following Stations and Services as follows quoted:

Station and Service.	Date of Order.	Description of Ordnance.	No.	Remarks.
7th Battery, 9th Brigade	22d Feb. 761 A. 4 / 18	Guns, 12-pr., Armstrong	6	Selected for 1st Battery, 8th Brigade.
8th Battery, 9th Brigade		Guns, 12-pr., Armstrong	6	Selected for 3rd Battery, 9th Brigade.

The P. M. Storekeeper, Royal Arsenal.

J. Lyons, Captain, Assistant Inspector of Artillery.

Station.	Nature.	No.	Register.
7th Battery, 9th Brigade	12-pr. 7 feet	269	
		279	
		295	
		322	
		335	
		340	
8th Battery, 9th Brigade	12-pr. 7 feet	190	
		198	
		270	
		280	
		287	
		332	

Appendix, No. 23.

LETTER from Messrs. *Whitworth & Co.*

App. No. 23.

(7662—16.)

(80—W.—442.)

Chorlton-street, Portland-street, Manchester,
Sir, 2d May 1861.

We beg to acknowledge your letter, 80 P.—W.—437, dated 27th April, giving us authority to receive back the gun (No. 83), supplied by us.

From the results of the proof trials with this gun, it would appear that the homogeneous metal cannot always be depended upon for large barrels, until arrangements can be made for insuring that they are perfectly annealed. Such arrangements we have already carried out for smaller barrels made of the same material, and we get them, when overstrained, to enlarge or bulge, and not to burst.

At present, the homogeneous metal we use for large cannons is necessarily annealed by the makers of the metal, who have not got the proper heating furnaces for the purpose, and we regret to say that it has not been so regular and uniform as we expected, and as it would be, if properly annealed.

We therefore should feel obliged if two barrels, made on the coiled system, might be supplied to us from the Royal Gun Factory, Woolwich, in a rough bored and turned state, which we would rifle, and finish, and return with the least possible delay.

If our proposition is acceded to, we shall be glad to be put in communication with the Superintendent of the Royal Gun Factory, and to furnish all the information respecting the dimensions and particulars of the barrels that may be required.

We are, &c.
(signed) *Joseph Whitworth & Co.*

The Under Secretary of State,
War Office, Pall Mall, London, S. W.

Appendix, No. 24.

War Office, 23 April 1863.

App. No. 24.

In reply to the Order of the Select Committee on Ordnance, dated the 20th April 1863, "That there be laid before the Committee—

I.—"A Copy of Lord Herbert's Order to Inspector of Artillery not to prove the Armstrong guns;"

II.—"Also, Copy of the Order of the War Office since the date of the above Order, for the Inspector of Artillery to prove the Armstrong guns:"

A copy of the Order first referred to is herewith enclosed.

No such Order as that last referred to has been issued, but the enclosed Papers (B.) are laid before the Committee as bearing upon the subject referred to.

Alex. T. Tulloh,
Director of Ordnance.

(A.)

(70—Gen. No.—892.)

Sir, 6 February 1860.

I am directed by the Secretary of State for War to transmit, for your information and guidance, the enclosed copies of letters, which have been addressed to the heads of the Manufacturing Departments, Woolwich, and Sir William Armstrong, C.B., relative to the inspection of stores.

I am, &c.
(signed) *H. R. Drewry.*

The Inspector of Artillery,
Royal Arsenal, Woolwich.

Gentlemen, 4 February 1860.

I am directed by the Secretary of State for War to inform you, that he has recently had under his consideration the subject of the inspection of stores for the Public Service, and that he has decided:—

1st. That, as a general principle, all stores manufactured in a Government Establishment shall be subject only to the inspection of the particular department in which they are made, and that the head of that department shall be held solely responsible for their being of proper quality and durability, and their exact conformity to pattern.

2d. That all stores supplied by the trade of the country shall be inspected by officers specially appointed for that duty by the War Department, the contractor being under no responsibility to the Government for articles once accepted.

I am, &c.
(signed) *B. Hawes.*

The Heads of the
Manufacturing Departments,
&c. &c. &c.

App. No 24.

Sir, 4 February 1863.

I AM directed by the Secretary of State for War to inform you, that he has recently had under his consideration the subject of the inspection of stores for the Public Service, and that he has decided:—

1st. That, as a general principle, all stores manufactured in a Government Establishment shall be subject only to the inspection of the particular department in which they are made, and that the head of that department shall be held solely responsible for their being of proper quality and durability, and their exact conformity to pattern.

2d. That all stores supplied by the trade of the country shall be inspected by officers specially appointed for that duty by the War Department, the contractor being under no responsibility to the Government for articles once accepted.

Under this decision the guns which are made by the Elswick Ordnance Company, as well as all other guns supplied by the trade under contract, will henceforth be inspected by a Government officer, but the guns and ammunition, &c. which are manufactured in the Royal Gun Factories will be issued for service upon the sole responsibility of the Superintendent, without any further inspection.

I am, &c.
(signed) *B. Hawes.*

Sir William Armstrong, C. B.,
8, Great George-street, Westminster.

(B.)

(73—3—3740.)

COPY of a MINUTE of the Director of Ordnance.

ALL guns manufactured in the Royal Gun Factory since the 4th February 1860, when Lord Herbert decided that "the Superintendents of the Manufacturing Departments should be held responsible for the articles they manufactured," have been proved, according to the proof regulations, by the Superintendent of the Royal Gun Factory, and if, after examination, they were considered by him to be serviceable, he passed them into the service, he being alone responsible.

In the same manner, the Inspector of Artillery proved the guns received from contractors, and the guns were paid for, if they passed this proof.

On the 4th May 1860, Lord Herbert agreed, on the representation of Sir William Armstrong (21 April 1860), on the advisability of firing 20 rounds to develope flaws near the surface of the bore—this to be considered apart from the proof—to be fired by the Royal Artillery in practice, a mechanic from the Royal Gun Factory being in attendance.

See No. 9 Return, Appendix.

On the 26th June 1860, Lord Herbert approved of the 10 rounds being fired under the direction of the Inspector of Artillery (by the Royal Artillery), to whom it gave "the means of testing the efficiency of the shells, bursters, time, and concussion fuzes, received from the contractor."

(73—3—963. P).

Sir, War Office, 8 May 1860.

I AM directed by Mr. Secretary Herbert to inform you, in reference to your report of the 26th ultimo, that with a view of fully testing the wrought-iron breech-loading Armstrong guns, and ascertaining if any defects exist in them previous to their issue, he has approved of 20 rounds of ammunition being fired from each of the same by the Royal Artillery in practice (after the ordinary proof by you), a mechanic from the Royal Gun Factories being present at this practice. In applying this test to 12-pounders, they are to be fired with $1\frac{3}{4}$ lbs. of powder; in the case of 40-pounders, $6\frac{3}{4}$ lbs. is to be used.

I have, &c.
(signed) *G. D. Ramsay,*
Assistant Director of Stores.

The Inspector of Artillery,
Woolwich.

(73—3—1097. P.)

Sir, War Office, 27 June 1860.

I AM directed by Mr. Secretary Herbert to inform you, in reply to your letter of the 16th instant, that he has approved of the present arrangements for the final proof of the Armstrong guns being continued, viz., of 10 rounds per gun being fired by the Royal Artillery under your directions, a competent artificer from the Royal Gun Factories being at the same time present.

I have, &c.
(signed) *J. Crawford Caffin,*
Director of Stores.

The Inspector of Artillery,
Woolwich.

The firing of these rounds by the Royal Artillery ceased in March 1861.

In explanation, it only remains to be stated, that as the Inspector of Artillery is charged with keeping the records of all guns, and making the selection for issues, it is necessary he should satisfy himself as to the identity of the Gun Factory guns with reference to a statement supplied by the Royal Gun Factory; but this does not invalidate the responsibility of the Superintendent of the Royal Gun Factory.

No doubt these circumstances have caused an impression, that since Lord Herbert's Order of 4th February 1860, the Inspector of Artillery has proved and examined the Royal Gun Factory guns, before and after proofs, in the same way as he has those received from contractors, which is not the case, and it would have been in direct disobedience of Lord Herbert's Order had such a course been adopted.

It must be recollected, that the established proof of all guns is laid down by the Ordnance Select Committee; the 20 rounds ordered to be fired by the Royal Artillery was never considered as

as any part of the proof, nor was it laid down by the Ordnance Select Committee.

Previous to the 4th February 1860, as Inspector of Artillery, I passed into the service 119 12-pounder guns made in the Royal Gun Factory, two of which, viz., Nos. 16 and 32, were lined guns, and have been issued.

All the other 12-pounder guns made in the Royal Gun Factory, amounting to 245, were proved and passed into the service by the Superintendent of the Royal Gun Factory, out of which 161 were lined guns, and of which about 81 have been issued. App. No. 24.

(signed) *A. T. Tulloh*,
Director of Ordnance.

11 March 1863.

Appendix, No. 25.

CORRESPONDENCE relating to Rifled Cannon. App. No. 25.

(80—Gen. No.—62.)

War Office,
Sir, 8 September 1858.

I am directed by Secretary Major General Peel to inform you that he has decided, with the concurrence of His Royal Highness the General Commanding in Chief, on appointing you to serve as President of a Special Committee intended to consider and report upon the important question of the best form of Rifled Cannon for adoption in Her Majesty's service, as well as of the projectile to be used with it.

Secretary Major General Peel desires that this inquiry should be directed to ascertaining the best patterns of rifled gun for garrison and for field service respectively.

Various experiments have, during a considerable period past, been undertaken by the Ordnance Select Committee, with this object, and I am directed to transmit to you the accompanying six copies of a memorandum which has been drawn up by Lieut. Colonel Lefroy, R.A., at the request of Major General Peel, and which resumes the more important results which have been obtained during the past stages of the inquiry.

Additional papers relative to experiments with particular forms of rifled cannon exist in this office, and the Committee will at all times be allowed access to any of them on your expressing a desire to that effect.

Secretary Major General Peel abstains from entering into details respecting the course to be followed by the Committee in this investigation, and confines himself to observing, that the question which is submitted to their consideration is one which it is now of paramount importance to bring to such a conclusion as will enable the Secretary of State to arrive at a speedy decision respecting the form or forms of rifled gun to be adopted in Her Majesty's service.

With this view, Major General Peel does not wish time to be lost in the pursuit of possible improvements. Such improvements may be sought and investigated at a future period. His present object is to ascertain whether there be now in existence any pattern or patterns of rifled cannon fit for adoption into the service.

The Committee is accordingly empowered immediately to proceed to such experiments as they may consider necessary, and to make demands on the principal Military Storekeeper, Woolwich, for such guns, ammunition, &c., as they may require, reporting in each case to this office such requisitions as they may make.

They will report minutely to the Secretary of State the results obtained by experiment, and the conclusions at which they may arrive.

The Committee will consist, in addition to yourself, of the following officers, who will receive their instructions from yourself:

Colonel Smythe, R.A.
Lieut. Colonel D'Aguilar, R.A.
Captain Sir W. Wiseman, Bart., R.N.
Brevet Major Wemyss, R.M.A.

and a Secretary not yet named.

I am, &c.
(signed) *J. R. Godley.*

Colonel Mitchell, R.A.
&c. &c. &c.
Shoeburyness.

P.S.—The accompanying memorandum is forwarded to the Committee as presented to Secretary Major General Peel; but the recommendations contained in the last two pages are not to be considered as approved in detail, or as instructions to the Committee.

8, Great George-street, Westminster,
Sir, 17 September 1858.

I have to acknowledge the receipt of your letter of the 15th inst., detailing certain general principles to be observed in the construction of rifled ordnance, and inviting observations on my part in reference to this subject.

My views in regard to rifled cannon, and the projectiles to be used therewith, are perhaps sufficiently expounded by the gun, shells, and fuzes which I have already made for the War Depart-

App. No. 25.

ment; but if your Committee desire it, I shall be glad to lay before them, on another occasion, some written remarks on the subject.

In the meantime I may state that the following additional guns are now nearly completed, and may shortly be delivered at Shoeburyness:—

1st. An 18-pounder, weighing 12 cwt., with recoil slide and pivot movement.

2d. An 18-pounder, weighing 18 cwt., without the recoil slide.

3d. A 12-pounder, weighing 12 cwt., without recoil slide.

4th. A 12-pounder, weighing 8 cwt., without recoil slide, and specially designed for horse artillery.

5th. A 6-pounder, weighing under 3 cwt., with recoil slide, and intended for warfare in roadless countries.

6th. A 32-pounder, weighing 26 cwt., with recoil slide, and mounted for garrison or naval service.

The first three on the above list have been made under the authority of the Secretary of State for War, and the remainder will be submitted to the Committee on my own responsibility.

I have, &c.
(signed) *W. G. Armstrong.*

Colonel Mitchell, R.A., &c. &c. &c.
Rifled Cannon Commission.

Chorlton-st., Portland-str., Manchester,
Sir, 14 October 1858.

I HAVE to acknowledge the receipt of your letter of the 23d ult., in which you ask for a statement of my views on the subject of rifled cannon, and if I have any proposition to make. Absence from home has prevented me from sending an earlier reply.

For a general statement of my views on the subject, I beg to refer you to my report addressed to Lord Panmure, dated 13th June 1857, a printed copy of which you would obtain at the War Office.

When I bored and rifled the howitzers and guns for the Government (the former nearly three years ago), I expected to have obtained valuable data, by their being submitted to a regular course of practice. This, I hope, will now be done, and that facts will be supplied, especially with regard to shell practice, which will show exactly what is still required.

In my opinion, it is wrong to use iron cast in solid masses, as at present, for large rifled guns; at the same time I am fully convinced that rifled 68-pounders may be constructed strong enough to bear any requisite charge without making them heavier than the present guns, and that their shot may be driven through 4-inch plates from considerable distances, and even through much thicker plates.

When the Committee favour me with a visit in Manchester, it will give me great pleasure to afford all the information in my power.

I am now making for myself a field-gun so light that experiments may be made with it here, and I shall be happy to communicate the results to the Committee.

I am, &c.
(signed) *Joseph Whitworth.*

Lieut. Colonel Mitchell, R.A.,
President of Rifle Cannon Committee.

151, New Bond-street,
Sir, 15 October 1858.

PERILOUS incidents, great domestic affliction, and extreme occupation in business at this season have kept my mind from an earlier consideration of your letter of 24th September 1858, which I have now before me, having read it with becoming attention, and gravely considered its important contents.

You address me for information "as one of the gentlemen who have given the subject of rifled cannon serious attention, the Committee will feel much obliged if you will furnish them with your views on the subject."

A reference to my correspondence and conferences with Sir Thomas Hastings and Colonel Chambers, and to the inter-communications with other authorities, will best establish my claim to be recognised as the one who had thrown his whole bodily and mental energies on to the subject, with considerable sacrifice and loss; and now it may strike you, as it has occurred to my mind, that in asking for my views, you call for an essay on the subject under my hand, when I am not prepared to give it; for I have to regret that the tenor of the replies received in answer to my letters to the War Department of Her Majesty's Government at present prevents my self-devotion to the Committee; at the same time allow me to say, I shall have a pleasure, when existing impediments are removed, by a recognition of my just claims, to furnish the best information I can communicate, and in all ways co-operate with the authorities of Her Majesty's Government for the general good.

Permit me, in conclusion, most courteously to apprise your Committee, that I cannot recognise the improperly assumed fact, that the Government have in any degree purchased the right of using the Lancaster principle, either in reference to rifling cannon or fabricating shells.

In a separate form, and as a new matter, I propose sending to your Committee in the meantime the result of some years thought and of expensive experiment in the production of it, a metal which I have so far ascertained as being especially adapted to rifle cannon.

I am, &c.
(signed) *Charles W. Lancaster.*

To Captain Noble, R. A.,
the Committee on Rifled Cannon,
Shoeburyness.

Rifled Cannon.

At the request of Lord Hardinge, three brass 24-pounder howitzers were sent down from Woolwich.

These I bored and rifled hexagonally, the bore being 4½ inches in diameter, measured diagonally, and 4 inches across the flats, and 52 inches long, and weighing 12 cwt.

One of the pieces I tried in my own grounds near Manchester at short ranges, both point blank, and at high elevations, with different lengths of projectiles. I fired from it projectiles weighing 12, 24, 32, 48, and a shell 100 lbs. weight, 10 calibres in length.

When fired point blank, with the small charge rendered necessary by my limited range, they ricochetted with great effect, and every time they bounded from the earth they left the mark of the spiral indented in the sod.

Another of the rifled howitzers was sent to Shoeburyness, and was there tried before some members of the Woolwich Select Committee.

The following are some of the results obtained :—

Weight of Shot Fired.	Angle of Elevation.	Charge.	First Graze.
		Lbs.	*Yards.*
32	5°	2½	1,635
48	5°	2½	1,160
32	7°	2½	2,020
48	7°	2½	1,440
32	14½°	2½	3,240

One of the evils of allowing for windage, by using a spherical shot of a smaller size than the bore, has been that the shot falls by gravity to the lower side of the piece, and being started with its centre eccentric to the bore, it is driven along the piece with a bounding motion, causing great wear and tear, and issues from the muzzle with much uncertainty.

The polygon projectile always issues from the piece concentric with the bore, and I am able to make the necessary allowance for windage, without impairing the effectiveness of the rifling surfaces, by simply "easing off" the half of each interior surface of the polygon.

Fenton's Hotel, St. James'-street,
Sir, 22 November 1858.

In reply to your letter of the 18th instant, which has been forwarded to me here, I would suggest that the 32-pounder gun should be fired with such a charge as would give a range of 2,100 yards at an elevation of 5 degrees. Should you be having any trials with the gun on Wednesday, if you will let me know, I shall be glad to come and witness them.

I am, &c.
(signed) *Joseph Whitworth.*

Captain Noble.

Committee on Rifled Cannon.

Shoeburyness, Essex,
Sir, 23 November 1858.

I am directed by the Committee on Rifled Cannon to acknowledge the receipt of your letter of yesterday's date, and to forward you a memorandum showing the hours up to which practice can be carried on here on the days named.

I am to request that you will inform me of the day on which it will be convenient for you to attend here. The Committee will be able to meet you on Friday or Saturday, or on any day next week, except Monday.

I have, &c.
(signed) *A. Noble*, Captain,
Secretary, R. C. Committee.

Joseph Whitworth, Esq.,
Manchester.

Appendix, No. 26.

App. No. 26.

PAPERS delivered in by Mr. *Brunel*, 27 April 1863.

LETTER from Mr. *Brunel*, to the Right Hon. *William Monsell*, M. P.

Sir, 18, Duke-street, Westminster, 27 April 1863.

I HAVE been informed that Mr. Whitworth has recently asserted in evidence before the Select Committee of which you are the Chairman, that he is in no way indebted to my father, the late Mr. Brunel, for the suggestion of the polygonal form of rifling.

Under these circumstances it would be highly satisfactory to me, as due to my father's memory, if I might be permitted to place before the Committee in any way that may be fitting, the whole of the correspondence in my possession bearing upon this subject; especially as Mr. Whitworth has, I am told, referred to a portion of that correspondence in his evidence.

I am, &c.
(signed) *I. Brunel.*

CORRESPONDENCE referred to.

No. 1.

LETTER from Sir *I. K. Brunel* to Mr. *Westley Richards*, jun.

My dear Sir, 25 October 1852.

I HAVE long wanted to try an experiment with a rifle for the purpose of determining whether there is anything in a crotchet I have upon the subject; but I have been deterred from attempting it from the feeling that in these abominable patenting days (I hate patents) the chances were that if in the progress of my experiments any new result, good or bad, were observed, or a workman should think he saw something, a patent would be taken over my head, and, to say the least, I should be stopped in pursuing my own investigation—as has happened to me more than once. I have also been deterred by my not knowing whether the existing machinery for rifling barrels would enable me to obtain an increasing or varying twist from one end of the barrel to the other, as this would be necessary to make the experiment, and I should not care to incur the expense of a machine on purpose. My introduction to you through our mutual friend Whateley induces me to make the inquiry whether your apparatus, or mode of rifling, enables you to give such a twist, and, if so, whether you could and would make me a barrel? If so, I will trouble you with an explanation of my scheme, as I should have no secrets with you.

Yours, &c.
(signed) *I. K. Brunel.*

No. 1 A.

EXTRACT of a Letter of this date from Sir *I. K. Brunel* to Mr. *W. Richards.*

7 February 1853.

I TAKE this opportunity of mentioning again the subject I once wrote or spoke to you about. I want a rifle barrel, octagon shaped inside, the octagon having a twist rather more than usual, and an increasing twist, say twice as much at the mouth of the piece as at the breech. Can you make me such a barrel for an experiment? I will explain to you the object when we meet, as it can only be done *vivâ voce.*

No. 2.

LETTER from Sir *I. K. Brunel* to Mr. *W. Richards.*

18, Duke-street, Westminster,
My dear Sir, 26 November 1858.

I AM obliged to you for your communication on the subject of the octagon gun, and in acknowledging your courtesy and gentlemanly feeling I would add that it is only what I always felt I could rely upon from you.

I beg you will not hesitate to take out a license from Mr. Whitworth for octagon guns (if, as a matter of business, you think it convenient to do so) on account of any prior claim which you may know I could set up; and if you get a license for a nominal consideration, as I understand you can, of course, as a man of business, you should do so. I have

have no intention of interfering with Mr. Whitworth's patent, even to indulge the feeling I have against all patents and protective laws, which I consider have become the curse of the day, and the sources of the greatest injury to inventors and manufacturers, and still more to the public; and I should also be very sorry even to annoy my friend Mr. Whitworth merely for the sake of showing that I had previously made the gun (at least you made it for me), and I believe others have preceded me, which he has patented, and I assure you that I shall not consider your taking out a license as in any way a denial of this fact, of which you are cognizant.

I have never seen Whitworth's patent; what is it exactly that he does patent? It cannot be merely the polygon, because even if nobody had preceded me, that would have been already a copy of mine, which not only was made before he began his investigation, but was lent by me at your request to him I think before his patent. My rifle is, I am told, doing quite wonders at Woolwich, and I begin to think there must be something in the principle which I intended to introduce into it, and which is totally different from what I understood to be Whitworth's. I sought to use a comparatively loose ball, but which I thought would centre itself, both in position and direction, in the axis of the barrel by the peculiar action of a polygon within a polygon, acted upon by an increasing pitch, and it really seems, from the results, as if my theory was correct.

I am, &c.
(signed) *I. K. Brunel.*

No. 3.

EXTRACT from a Letter from Mr. *W. Richards* to Sir *I. K. Brunel.*

I FEEL obliged to you for your letter, which enables me to take a license from Whitworth without depriving you of the credit of the invention.

I do not exactly know what it is Whitworth claims in his patent, but it is a combination, including polygon barrels and shaped projectiles to fit.

(signed) *Westley Richards.*

No. 4.

LETTER from Mr. *J. Bennett* to Mr. *W. Richards*, 19 May 1859.

Dear Sir,

I SEE from Mr. Brunel's diary, that you had an interview with him on the 12th January 1855. On the 3d March 1855, the gun was addressed to you at Birmingham, and booked at the Great Western Railway Company's receiving office in Parliament-street. I cannot, however, find any letter either from yourself or Mr. Whitworth about that time.

No. 5. App. No. 26.

LETTER from Mr. *W. Richards* to Mr. *T. Aston.*

Birmingham,
My dear Sir, 30 May 1860.

I SEND in this letter the dates I promised; and, to prevent further mis-interpretation, will put into writing the view I have always taken of my case, and which I still take of it.

I was introduced to Mr. Brunel by Mr. George Whateley in 1852, for the purpose of carrying into effect an idea he had about an octagon rifle, and which he then explained to me. I received a letter from Mr. Brunel on other business, dated the 7th February 1853, in which he again mentions the subject of "the rifle barrel he asked me to make of an octagon shape."

Mr. Whitworth called on me on the 11th March 1854; this was the first time I saw him. From what he then said, I went down to Manchester the following day, the 12th of March.

Mr. Brunel's rifle was finished, and sent home to him on the 31st May 1854.

My appointment from the Ordnance Office to serve on the committee for carrying out experiments on rifles, is dated the 5th June 1854. After that date, I had frequent communications with Mr. Whitworth, in London, on the subject of the experiments, &c., and in addition to my first visit to Manchester, on the 12th March 1854, I went down again on the 17th April on my own account.

After my appointment on the 5th June, I went to Manchester on the 27th August, the 20th September, the 14th October, the 28th November, and the 21st December, all in the same year, 1854.

I have no means of ascertaining when Mr. Brunel's rifle was sent down to Manchester. I know it was not until after the shooting gallery had been opened for some time, and I think it was not for some considerable time after; but this I consider a matter of no importance.

It is now for Mr. Whitworth to show that he had conceived the idea of a polygonal rifle, and made a model of it previous to my acquaintance with him.

This is a point for Mr. Whitworth to decide with Mr. Brunel's friends. By taking out a license from Mr. Whitworth, which, however, I would not do till I had obtained Mr. Brunel's written consent, I have acquiesced in Mr. Whitworth's legal right to his patent, and have done all in my power to uphold that right.

Mr. Whitworth, I am told, considers that he has serious grounds of complaint against me, in connexion with subsequent proceedings. I will not at present enter into any discussion upon that subject, but I am prepared to show, whenever it may be necessary, that I am the aggrieved person.

Yours, &c.
(signed) *Westley Richards.*

Appendix, No. 27.

App. No. 27.

PAPERS delivered in by *John Anderson*, Esq., 27 April 1863.

CORRESPONDENCE relative to Mr. WHITWORTH'S 7-inch GUN.

No. 1.

(Immediate).
War Office, 13 December 1861.

THE Assistant Superintendent is authorised to put in hand a 7-inch gun, to be made in accordance with a drawing which will be furnished to him by Mr. Whitworth, with whom he will place himself in communication on the subject.

The Assistant Superintendent will also prepare five brass 9-pounder blocks, which will be bored and rifled by Mr. Whitworth.

The Assistant Superintendent will be good enough to report the estimated cost of executing the above order, and to state when the guns will be ready.

(signed) *A. T. Tulloh*,
Director of Ordnance.

The Assistant Superintendent
Royal Gun Factories.

No. 2.

Royal Gun Factories, Woolwich,
19 December 1861.

My dear Sir,

WITH reference to the War Office order to put in hand for you five brass 9-pounder blocks, I herewith enclose a tracing, No. 12-67, showing the outlines of the gun (service pattern), and if you desire these guns to be finished in this manner, will you be so good as to return the tracing signed.

With respect to the 7-inch gun, a tracing of which I received from you, I have prepared two drawings, Nos. 68 and 69—W., now enclosed, showing a gun finished to the outlines of your drawing, but constructed according to a simpler arrangement of the coils, and one which I would recommend for your consideration, in preference to your proposal to use hydraulic pressure, and screwing the coils together. The only difference between the drawing is, that one has a solid-ended tube, and the other an open tube and breech screw. Either of these plans can be rifled according to your principle, but, of the two, the close-ended tube, for the sake of avoiding any joint in the powder chamber, would appear the best, but my desire is to carry out your wishes in this matter.

I am, &c.
(signed) *J. Anderson*,
Assistant Superintendent Royal Gun Factories.

J. Whitworth, Esq.,
Manchester.

No. 3.

Manchester,
My dear Sir, 20 December 1861.

I RETURN you the enclosed, which I have signed with much pleasure. The proceedings of the British Association this year, is forwarded by book post.

Mr. Hulse is going up to town on Sunday evening for two or three days, and will have the pleasure of seeing you.

The 9-pounder brass blocks we shall be glad to receive as soon as possible. In the morning, I go to Shorncliffe, by way of Sheffield, where I shall stay a couple of hours to look after homogeneous iron.

Yours, &c.
(signed) *Joseph Whitworth.*

J. Anderson, Esq.

No. 4.

Manchester,
My dear Mr. Anderson, 20 Dec. 1861.

MR. WHITWORTH thinks I had better run up to see you. Will you please telegraph me saying whether Monday or Thursday next will find you most disengaged. Excuse great haste.

Yours, &c.
(signed) *W. W. Hulse.*

John Anderson, Esq.

No. 5.

Mr. *Anderson*, Royal Arsenal, Woolwich, to Messrs. *Whitworth* & Co., Charlton-st., Manchester.

I CAN see Mr. Hulse on Monday, but it would not be convenient on Thursday.

No. 6.

Sackville-street, Manchester,
Sir, 21 December 1861.

WE beg to acknowledge your letter of the 19th inst., and to return the tracing of the 9-pounder gun blocks, duly signed by Mr. Whitworth. We shall be glad to receive the blocks as early as convenient, as we are quite prepared to do the boring and rifling of the five as soon as we receive them.

We have also to acknowledge the receipt of tracings W—68 and W—69 of the 7-inch gun which

which Mr. Hulse will see you about at Woolwich on Monday morning.

Would you please inform him then respecting the sights of the brass blocks.

We are, &c.
(signed) The Whitworth Ordnance Company, per *H. M.*

John Anderson, Esq.,
Royal Gun Factories, Woolwich.

No. 7.

Mr. Anderson presents his compliments to the Whitworth Ordnance Company, and with reference to his promise to Mr. Hulse, begs to forward a tracing No. 82—W, showing an amended build of muzzle-loading gun. Mr. Anderson also begs to return herewith the four tracings which were left by Mr. Hulse.

Royal Gun Factories, Woolwich,
24 December 1861.

No. 8.

Sackville-street, Manchester,
Sir, 26 December 1861.

We are in receipt of your favour of the 24th instant, and beg to inform you that Mr. Whitworth has just returned from Derbyshire, and has seen the tracing 82—W, showing the construction proposed for the 7-inch gun to be made at Woolwich, and rifled on Mr. Whitworth's principle.

Considering that the mode of construction which Mr. Whitworth would have preferred and which we have explained to you, cannot, with the facilities now existing at Woolwich be conveniently carried out, we will avail ourselves of your offer to undertake the responsibility, and to leave the details of construction entirely to yourself. We may, however, ask you to consider the propriety of omitting the outside hoop shown on tracing 82—W, and welding the next series of hoops together, so as to avoid the joints. This would reduce the weight of gun to about 7 tons. We venture to express a hope that the gun may be proceeded with all possible dispatch.

We are glad to hear from Mr. Hulse that we are likely soon to receive the brass gun-blocks, and beg to ask you to send the sights with them.

We are, &c.
(signed) The Whitworth Ordnance Company.

J. Anderson, Esq.
Royal Gun Factories.

No. 9.

Royal Gun Factories,
Gentlemen, 31 December 1861.

With reference to your letter, dated 26th instant, I beg to enclose a tracing 87—W, showing the 7-inch muzzle loading gun slightly altered in the exterior diameter at breech. With respect, however, to the removal of the outside coil, I am of opinion that this coil is indispensable to the strength of a gun constructed on the plan proposed, and with regard to the welding of the series of hoops under the exterior coil, these hoops are of much larger diameter than we have yet done, and I am unwilling to run any risk with this gun.

If this tracing meets with your approval, I shall feel obliged by your returning it with Mr. Whitworth's signature to serve as an authority for proceeding with this construction of gun, the manufacture of which will be carried out with all possible dispatch.

I am, &c.
(signed) *J. Anderson.*

The Whitworth Ordnance Company.

No. 10.

Sackville-street, Manchester,
Sir, 3 January 1862.

We beg to acknowledge your favour of the 31st ultimo, enclosing tracing W—87, showing the 7-inch M. L. gun as you propose to make it. We return the tracing signed by Mr. Whitworth as an authority to proceed with its manufacture.

We are sorry to trouble you again about the brass guns, but should be glad if you could send us one or two of them immediately.

We are &c.
(signed) *Joseph Whitworth & Co.*

J. Anderson, Esq., Royal Gun Factories,
Royal Arsenal.

No. 11.

Mr. Anderson presents his compliments to the Whitworth Ordnance Company, and begs to acknowledge the receipt of their letter of the 3d instant, enclosing a tracing W—87 of 7-inch muzzle loading gun, signed by Mr. Whitworth.

Royal Gun Factories,
Woolwich, 6 January 1862.

No. 12.

Royal Gun Factories, Woolwich,
Gentlemen, 10 January 1860.

With reference to the 7-inch wrought iron muzzle loading gun we are now making for you in this department, I beg to request that you will be be good enough to forward at your convenience, a tracing showing the manner in which it is proposed to have this gun rifled, and also the amount of twist to be given to the rifling, with any other information in connexion therewith, which you may consider it necessary for this department to have.

I am, &c.
(signed) *John Anderson,*
Assistant Superintendent.

The Whitworth Ordnance Company,
Manchester.

App. No. 27.

No. 13.

Manchester, 21 January 1862.

My dear Mr. Anderson,

I AM very sorry to inform you, and you will be equally so to learn that Mr. Whitworth is again and has been for the last two days confined to his bed by serious indisposition; both his physicians say it is absolutely necessary that he shall not see any one (except his attendants,) or hear, or do any business for a few days to come. We have the drawing of the 7-inch gun ready, and a tracing, but it requires Mr. Whitworth's signature before I should like to send it, and indeed before you would like to receive it. However, if you would like to proceed with the boring, I may inform you that the cylindrical bore will be 6·4 inches diameter, the pitch of the rifling will be one turn in 140 inches. Immediately I get Mr. Whitworth's signature I will send you the tracing. I hope our telegram, re-screwing apparatus, was satisfactory.

Ever yours, &c.
(signed) *William Hulse.*

No. 14.

Whitworth Ordnance Company,
Chorlton-street, Manchester.

WE shall be ready to begin boring 7-inch gun to-morrow, and shall be glad of particulars, asked 10th January.

I am, &c.
(signed) *W. J. Andrews.*

John Anderson, Assistant Superintendent
Royal Gun Factory, Woolwich.

No. 15.

Sackville Street, Manchester,
Sir, 24 February, 1862.

IN further acknowledgment of your favour of the 10th January, we are preparing a set of gauges for the 7-inch gun.

We will forward you the cylindrical gauge first, immediately on its completion, and the hexagonal gauges shall follow as soon after as possible.

Apologising for the delay,

We are, &c.
Pro the Whitworth Ordnance Company,
(signed) *T. C.*

J. Anderson, Esq.,
Assistant-Superintendent, Royal Gun Factories,
Woolwich.

No. 16.

Sackville Street, Manchester,
Sir, 20 March 1862.

WE beg to advise you that we have this day dispatched per Messrs. Pickford & Company to your address at the Royal Arsenal, Woolwich, one case, containing—

2 gauges for 7-inch bore gun.
1 internal and external cylindrical gauge, 6·425 inch.
1 internal and external hexagonal gauge:
7 inches across corners,
6·4 „ „ flat,
Pitch 1 in 130 inches.

We are, &c.
(signed) The Whitworth Ordnance Company.

J. Anderson, Esq.,
Royal Gun Factories, Woolwich.

No. 17.

Sackville Street, Manchester,
Sir, 22 March, 1862.

WE have sent you per post a gauge for the windage for the 7-inch bore Whitworth gun now making at Woolwich.

Enclosed we send you a diagram showing all the dimensions of bore, windage, &c. On Thursday we sent you per railway the following gauges, viz.:—

Internal and external cylindrical gauges, being for the cylindrical portion of bore 6·425 diameter.
Internal and external hexagon gauges for the polygonal bore:
Across flats - - 6·4
Across corners - 7·0
The pitch of rifling is one turn in 130 inches.

We are, &c.,
(signed) The Whitworth Ordnance Company.

J. Anderson, Esq.,
Woolwich.

No. 18.

MR. ANDERSON presents his compliments to Messrs. Whitworth & Company, and begs to acknowledge the receipt of the gauge and tracing contained in his letter of 22d inst.; also the gauges advised by his letter of the 20th inst.

Royal Gun Factories, Woolwich,
24 March 1863.

No. 19.

Royal Gun Factories,
Gentlemen, 26 March 1862.

I SHALL feel obliged by your informing me whether the tracing last received from you, showing the section at muzzle of your 7-inch gun, represents the gun in its proper position; that is to say, does the red line I have caused to be drawn, represent the horizontal axis of gun through the trunnions or otherwise. I have also to request that you will state whether it is particular as to the finish of the hexagonal rifling at the inner end of bore. The enclosed sketch shows

shows the dimensions to which it is thought the rifling can be easily accomplished in this department; and if it meets your approval, it shall be done; if not, however, I shall be happy to meet your wishes.

Your returning the tracing, will oblige.

I am, &c.
(signed) *J. Anderson*,
Assistant Superintendent.

The Whitworth Ordnance Company.

No. 20.

Sir, Manchester, 27 March 1862.

We beg to acknowledge the receipt of your letter of the 26th instant. The red line on the tracing enclosed represents the horizontal axis of the gun through the trunnions.

The hexagonal rifling will do to be finished at the breech, as shown in the hand sketch enclosed, and to the dimensions given on the sketch.

We return the tracing as requested, and remain,

Yours, &c.
(signed) The Whitworth Ordnance Company.

J. Anderson, Esq.,
Royal Gun Factories, Woolwich.

No. 21.

Royal Gun Factories,
Gentlemen, 27 March 1862.

I beg to enclose, for your consideration, two tracings, W—185 and 186, showing a proposed arrangement of sighting the 7-inch muzzle-loading gun, now being prepared for you in this department. If it meets your approval, please return it signed. I shall, however, be happy to sight the gun in any other manner which you may desire.

I also enclose a tracing, W—187, showing the vent-hole in the gun at the same angle as those in the 68-pounder service guns, and have to request that you will inform me whether you should wish this hole drilled in the gun before proof, or that the gun should be proved without a vent-hole at all.

I am, &c.
(signed) *J. Anderson*,
Assistant Superintendent.

The Whitworth Ordnance Company,
Manchester.

No. 22.

Sir, Manchester, 1 April 1862.

We are exceedingly sorry that through pressure of business your letter of the 27th ultimo was not answered by return.

We herewith return the tracings you sent us showing the sighting, which we have signed as requested.

The vent-hole we will leave entirely with you. If you think it better not to vent before proof, please carry it out, or if you prefer to vent before proof and to copper-bouch the hole after, you will oblige us by doing so.

In our own guns we have generally proved before venting.

Would you kindly inform us how soon you think the gun will be finished?

We are, &c.
(signed) The Whitworth Ordnance Company.

John Anderson, Esq.,
Woolwich.

No. 23.

Royal Gun Factories,
Gentlemen, 4 April 1862.

With reference to the last paragraph of your letter of the 1st instant, I beg to inform you that the 7-inch muzzle loading gun preparing for you in this department will be ready by the 18th instant.

I am, &c.
(signed) *J. Anderson*,
Assistant Superintendent.

Messrs. Whitworth,
Manchester.

Appendix, No. 28.

App. No. 28. A RETURN from Her Majesty's Ship "Excellent" of Trials of Rifled Ordnance since 1st January 1858, forwarded in obedience to Order of the Select Committee on Ordnance, dated 27th February 1863.

Admiralty, 13 April 1863.

COPIES from First Experiment Book, commencing 22d December 1857.

INDEX.

NO.	DATE.	TRIAL.	RESULT.	PAGE.
1	22 Dec. 1857 -	Whitworth's 24-pounder howitzer. To ascertain whether, when fired from above water, its flat-headed shot would penetrate under water.	Firing with 5½° depression, it penetrated through 13 feet of water, and then 13 inches of oak; but after penetrating 20 feet of water, the velocity became so much reduced that when it struck the target it only grazed. Distance of target 100 feet. Gun 6 feet 6 inches above the water.	408
	16 March 1858 -	Continued - - -	Continued - - - - - - -	413
2	8 Oct. 1858 -	Whitworth's 68-pounder cast-iron gun. To ascertain its effect against iron plates.	At the seventh round gun burst. Loading very difficult after the first round. At 450 yards the shot of wrought iron passed through 4-inch wrought iron plate and ship's side.	416
3	22 Feb. 1859 -	Armstrong 32-pounder. To ascertain whether the carriage was suitable for naval purposes, and whether the shot would penetrate under water.	Carriage worked well; it is however complicated in its structure, and altogether unfit for between decks. Shot would not penetrate the water, owing to the hemispherical shape of the head.	417
4	21 to 23 Nov. -	Armstrong 70 and 32-pounders on board the "Wrangler."	Guns worked well, but both guns and carriage require modification.	420

— No. 1. —

Mr. Whitworth's 24-Pounder Rifled Howitzer.

H. M. S. "Excellent," 22 Dec. 1857.

Mr. Whitworth's 24-pounder rifled howitzer was received on board for trial; it was a common service brass howitzer of between 13 and 14 cwt., 4 feet 8 inches length, which had been supplied to Mr. Whitworth for the purpose of rifling; the bore was hexagonal, with the angles rounded off; the diameter, taken from centre of one face to the other = 4 inches, but from one angle to another = 4½ inches. The bore, 4 feet 6 inches in length, had a turn to the right of 1 in 40 inches; and that half of each side of the hexagon against which the shell presses as it turns on being rammed home, was eased off, from 1-50th of an inch at the angle to nothing at the centre, to allow for windage in loading; but that half of each side against which the shell presses as it turns on leaving the gun was not eased off, thus ensuring the concentricity of the projectile with regard to the axis of the bore when fired. *See* Fig. 1.

The projectile (a shell) was of the same form as the bore, but the sides of it were perfectly plain; it measured 10·3 inches in length, and 3 inches in diameter at the point, and 4 inches at the base, and its weight was 24 lbs. Thickness of shell at base and point = 1 inch; at the side the thickness = ·6 inch. *See* Fig. 2.

The following number of rounds were fired from the battery, to ascertain its penetration through water, with 2½ lbs. charges, at a wooden butt, 9 feet in height by 8 feet, constructed of 4-inch oak plank, nailed on two piles, and distant 32 yards from the battery. *See* Fig. 3.

After the third round the butt was doubled with oak plank, making it 8 inches thick. The gun was 15 feet above a horizontal plane, passing through the foot of the butt; the shell held 1 lb. 3 oz. of powder, and still leaving room to put in the fuze.

FIG. 1.

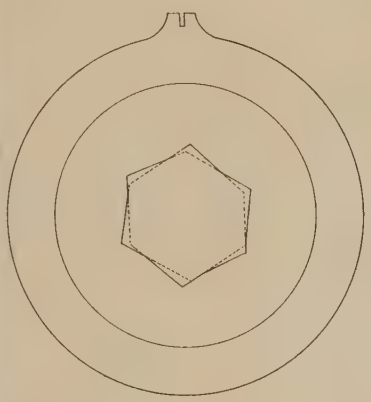
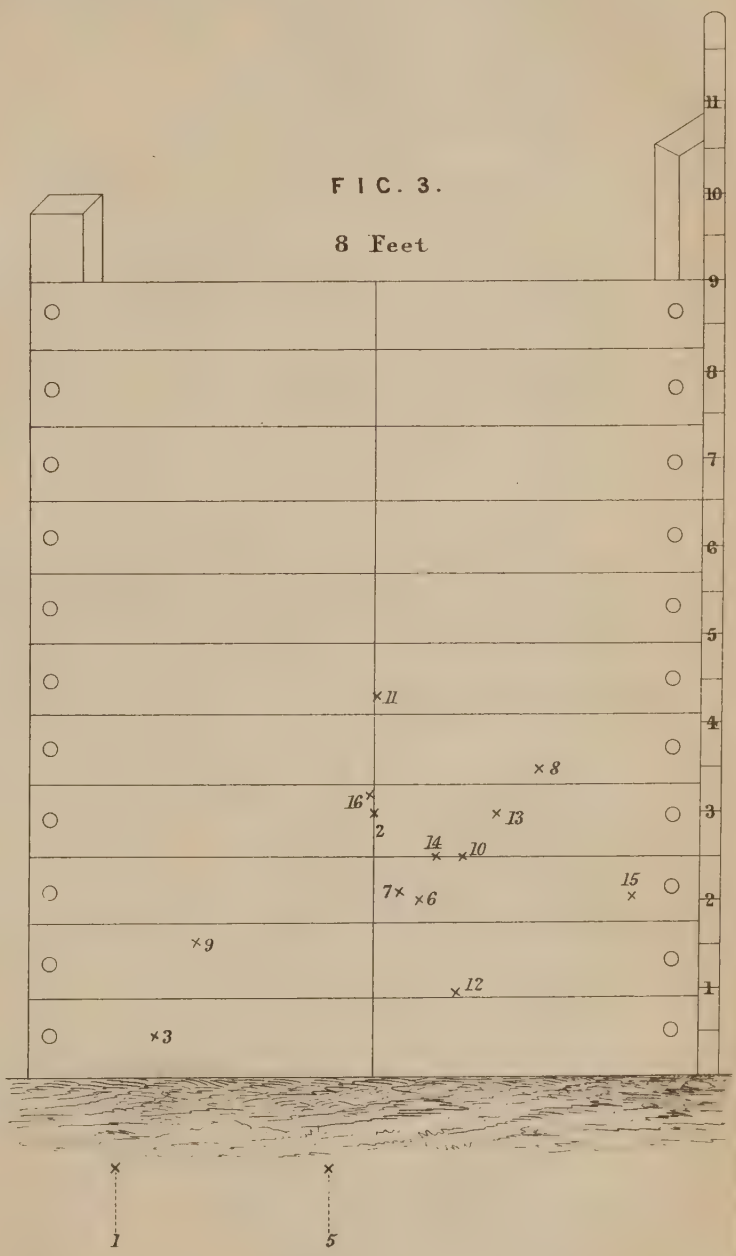


FIG. 2.

FIG. 3.

8 Feet



Nº 487. Ordered, by the House of Commons, to be printed, 23 July 1863

Henry Hansard

No. 1.—Mr. Whitworth's 24-Pounder Rifled Howitzer—*continued.*

No.	Depression by Spirit Level.	Height above Plane.	Height of Water above Part Aimed at.	Height of Water above Part Struck.	REMARKS.	
	° ′	*Ft. in.*	*Ft. in.*	*Ft. in.*		
1	8 0	9 6	4 0	5 6	The howitzer was laid for the centre of butt, and for a point 18 inches from the bottom.	The shell entered the water 28 feet from the butt, and entered the mud 1 foot short of and 3 feet to the left of centre of butt, penetrating 3 feet into the mud. The shell retained its angular direction, and would doubtless have gone deeper into the mud, had it not been for pieces of wood sticking in the way; the shell therefore passed through 28 feet of water before entering the mud, the water being 5 ft. 6 in. deep at that point. The total penetration through soft mud and water, 31 feet. Deflection, left, 3 feet.
2	7 0	10 0	2 0	3 0	The howitzer was laid for the centre of butt, and for a point 3 feet from the bottom.	The shell entered the water 15 feet from the butt, passed through the butt 3 feet from the bottom, in line with the centre; in doing which, it must have been canted up a little, as it ranged on through the water, entering the mud 14 feet beyond the butt, and penetrating 18 feet into it to a point 6 ft. 6 in. below the surface. The shell was recovered. Total penetration through soft mud, wood, and water, 47 feet. Size of hole in butt, 4½ by 3½ inches.
3	7 45	8 6	4 9	6 0	The howitzer was laid for a point 1 ft. 9 in. from lower part of butt, and at its centre. After third round the butt was doubled with oak plank, to increase the resistance in passing through, making it 8 inches thick.	The shell entered the water 34 feet from butt, passed through the butt 6 inches from the bottom, and 2 ft. 6 in. to the left of the centre, then through 2 feet of water and 3 feet of mud. Wood in butt splintered a good deal. The shell was recovered. Total penetration through water, wood, and mud, 39 feet. Deflection, left, 2 ft. 6 in.
4	7 30	7 8	5 4	7 4	The howitzer was laid for the centre of the butt, and 2 feet from the bottom.	Shell struck the water 37 feet from the butt, passing clear of it 6 feet to the left of the centre, entered the mud 2 feet in rear of the butt, and penetrated 10 feet through it to a point 5 feet below the surface, in a direction apparently nearly straight from the howitzer. The projectile was found point foremost in the mud, and had preserved the angle with which it was fired throughout its trajectory. Total penetration through water and mud, 49 feet. Deflection, left, 6 feet.
5	7 30	7 8	5 4	7 4	The howitzer was laid for a point 2 feet from the bottom of the butt, and 2 feet to the right of the centre.	Shell struck the water 37 feet from the butt, passing under it about 3 feet below the point aimed at, and 2 ft. 6 in. to the left of it; it then entered the mud, and penetrated 7 ft. 6 in. through it, to the depth of 3 ft. 6 in. Shell found, point foremost. Total penetration through water and soft mud, 45 feet. Deflection to left, 2 ft. 6 in. Recoil: Whitworth's, 11 ft. 6 in.; common howitzer, 13 ft. 6 in. (Trucks off.)
6	7 0	7 8	4 4	5 4	The howitzer was laid for a point 3 feet from the bottom of the butt, and 2 feet to the right of the centre.	Shell struck the water 34 feet from the butt; it then struck the butt 1 foot below and 1·5 foot to the left of the point aimed at, but with so little velocity, that it merely left the impression of the face of the shell and of the plug in the wood; it then dropped into the mud at the foot of the butt. Total penetration through water, 34 feet. Deflection to left, 1 ft. 6 in. Recoil: Whitworth's, 11 ft. 3 in.; common howitzers, 12 ft. 6 in. (Trucks off.)

No. 1.—Mr. Whitworth's 24-Pounder Rifled Howitzer—*continued.*

No.	Depression by Spirit Level.	Height above Plane.	Height of Water above Part Aimed at.	Height of Water above Part Struck.	REMARKS.	
	° ′	*Ft. in.*	*Ft. in.*	*Ft. in.*		
7	7 0	7 8	4 4	5 2	The howitzer was laid for a point 3 feet from the bottom of the butt and 2 feet to the right of the centre.	The shell entered the water 34 feet from the butt, and struck the butt 2 ft. 2 in. from the bottom, and 1 ft. 8 in. to the left of the point aimed at, making an impression in the butt ½ inch deep only, and dropped into the mud at the foot of the butt. Total penetration, 34 feet; deflection, left, 1 ft. 8 in. Recoil: Whitworth's, 11 ft. 3 in.; common howitzer, 12 ft. 6 in. (Trucks off.)
8	6 30	9 0	2 0	2 6	The howitzer was laid for a point 4 feet from bottom and 2 feet to right of centre line.	The shell entered the water 17 feet from butt, passed through the butt about 3 ft. 6 in. from the bottom in the same direction as it was fired, entered the mud 17 ft. 6 in. beyond and penetrated 18 ft. 6 in. into it, to a depth of 2 feet below the surface. Total penetration through water, wood, and soft mud, 53 ft. Recoil: Whitworth's, 8 feet; common howitzer, 6 ft. 7 in. (Trucks off.)
9	7 0	9 6	2 6	4 0	The howitzer was laid for a point 3 feet from the bottom of butt and 1 foot to the right of centre line.	The shell entered the water 19 feet from butt, lodged in the butt, penetrating through the first face but not injuring the second face at all; the shell struck the butt obliquely, making a hole 7 ½ inches long by 4 inches wide, and 2 feet to the left of centre line 1 ft. 6 in. from the bottom. Total penetration, about 20 feet; deflection, left, 3 feet. Recoil: Whitworth's, 8 ft. 2 in.; common, 7 ft. 10 in. (Trucks off.)
10	6 45	9 9	1 9	2 9	The howitzer was laid for a point 3 ft. 6 in. from the bottom of butt and 2 feet to the right of centre line.	The shell entered the water 14 feet from butt, passing through the butt about 2 ft. 6 in. from the bottom, and 1 foot to the right of centre line; it then entered the mud 6 ft. 6 in. beyond, and penetrated 12 feet into it to a depth of 6 feet. Total penetration through water, wood, and soft mud about 33 feet; deflection, left, 1 foot.
11	7 0	9 0	3 0	1 8	The howitzer was laid for a point 3 feet from the bottom of butt and 2 feet to right of centre line.	The shell entered the water 23 feet from the butt, struck the butt on the centre line 4ft. 4 in. from the bottom, bruising the plank considerably, and dropped into the mud at the foot of butt. Total penetration, 23 feet; deflection to left, 2 feet.
12	7 30	10 3	2 9	3 9	The howitzer was laid for a point 2 feet from bottom of butt and 2 feet to right of centre line.	The shell entered the water 18 feet from the butt, struck the butt 1 foot from the bottom and 1 foot to the right of centre line, penetrating 4 inches; it then dropped into the mud at foot of butt. Total penetration, 18 feet; deflection, left, 1 foot. Recoil a little sharper with Whitworth's than with common howitzer. Trucks off and new cleats nailed on over bolts in fore axletree. The battery not broad enough to admit of recoil being taken, as it was very wet and slippy.
13	6 45	8 6	3 0	3 6	The howitzer was laid for a point 3 ft. 6 in. from the bottom of butt and 2 feet to the right of centre line.	The shell entered the water 24 feet from the butt, lodged in the butt at a point 3 feet from the bottom and 16 inches to the right of centre line, penetrating till the point appeared on the other side; two planks in the outer face were much shattered and displaced. Total penetration, about 25 feet; deflection, left, 8 inches. Recoil of Whitworth's sharper than with the common howitzer.

Diameter of vent ·23.

No. 1.—Mr. Whitworth's 24-Pounder Rifled Howitzer—*continued.*

No.	Depression by Spirit Level.	Height above Plane.	Height of Water above Part Aimed at.	Height of Water above Part Struck.	REMARKS.	
	° ′	*Ft.* *in.*	*Ft.* *in.*	*Ft.* *in.*		
14	7 0	9 6	2 6	3 0	The howitzer was laid for a point 3 feet from the bottom of butt, and 6 inches to the right of centre line.	The shell entered the water 19 feet from the butt, passed through the butt, where it was much broken by a previous round, at a point 2 ft. 6 in. from the bottom, and in the same direction as it was laid; it then entered the mud 17 feet beyond, and penetrated 16 feet to a depth of 5 feet below the surface. Total penetration through soft mud and water, 52 feet.
15	6 45	9 0	2 6	4 0	The howitzer was laid for a point 3 ft. 6 in. from the bottom of butt, and 2 feet to the right of centre line.	The shell entered the water 21 feet from the butt, struck the butt at a point 2 feet from the bottom, and 3 feet to the right of centre line; it shattered the plank a good deal, but only penetrated 2 inches, then dropped in the mud. Total penetration about 21 feet through water. Deflection, 1 foot right. Recoil: Whitworth, 14 ft. 3 in.; common howitzer, 15 ft. 5 in.
16	6 45	9 0	2 6	3 0	The howitzer was laid for a point 3 ft. 6 in. from the bottom of butt, and at its centre.	The shell entered the water 21 feet from the butt, passed through the centre of butt at a point 3 feet from the bottom, and fell in the mud 20 feet beyond. Total penetration through wood and water about 42 feet. It appears, therefore, from the above experiment, that the shell will pass through 8 inches of oak, after passing through 20 feet of water, at a point 3 feet below the surface.

The following Number of Rounds were Fired from the Battery with Mr. Whitworth's Rifled Howitzer and the common 24-Pounder Howitzer, to compare the range at different angles of elevation, using 2½ lb. charges, and pointing at a Target distant 950 yards.

Number.	Elevation.	Range.	Deflection.	REMARKS.
	°	*Yards.*	*Yards.*	
	Rifled Howitzer:			
1	4	1,450	4 right.	
2	4	1,450	6 „	
3	4	1,450	6 „	
4	3	1,310	3 „ - -	Second graze, 1,410 yards.
5	2½	1,000	1 „	
6	2	870	- -	Second graze, 1,350 yards.
7	1¼	450	- -	Last graze, 1,350 yards. Deflection at 950 yards = 130 yards right.
	Common 24-Pounder Howitzer:			
1	4	1,300	- -	Three grazes afterwards.
2	4	950	5 right -	- - ditto.
3	4	1,050	- -	Two grazes.
4	4	1,250	10 right.	
5	4	1,250	10 left - -	One graze.
6	4	1,050	3 right -	Three grazes.
7	¾	400	- -	Last graze, 1,950 yards. Deflection at 950 yards = 120 yards right.

The practice was from the launch against the "Serpent" brig, moored in the 800 yard creek.

No. 1.—Mr. Whitworth's 24-Pounder Rifled Howitzer—*continued.*

From the Launch at "Serpent" Brig.

No.	Depression by Spirit Level.	Height above Plane.	Height of Water above Part Struck.	REMARKS.	
	° ′	*Ft.* *in.*	*Ft.* *in.*		
1	7 0	4 0	2 2	The howitzer was laid for a point immediately under the centre of fore chains, and distant 54 feet.	The shell entered the water about 21 feet from the ship, passed through the side, 2 ft. 2 in. under water, a few inches to the left of the spot aimed at, and dropped in the hold; it grazed the side of a timber in going through, and the outside plank was 4 inch fir, and the inside lining 3 inch oak. Total penetration, 7 inches oak and fir combined, and 21 feet of water.
2	7 0	4 0	2 0	The howitzer was laid for a point immediately under the centre of after main chains, and distant 54 feet.	The shell entered the water about 21 feet from the ship, passed through the side between two timbers, 2 feet under water, a few inches to the left of the spot aimed at, and dropped in the magazine, passing through on the outside between an oak and fir plank 4 inches thick, then through the inner lining of 3 inch oak. The ship's bottom fell in very much at this part, thus rendering it more difficult for the shell to penetrate. Total penetration, 7 inches oak and fir combined, and about 22 feet of water.
3	7 30	4 0	3 4	The howitzer was laid for a point immediately under the centre of the space between cat-head and bill-board, and distant 54 feet.	The shell entered the water about 21 feet from the ship, passed through the side between two timbers, 3 ft. 4 in. under water, a foot to the left of point aimed at, and dropped in the hold; the outside plank was 4 inch fir, the inside lining 3 inch oak. The space between the outside and inside planking, 9 inches. Total penetration, 7 inches oak and fir, and about 21 feet of water. Deflection, 1 foot left.
4	7 30	4 0	5 0	The howitzer was laid for a point immediately under the centre of fore main chains, and distant 54 feet.	The shell entered the water about 21 feet from the ship, and grazed the side to the depth of about 1 inch in fir, and 5 feet under water, and dropped in the mud. The ship's side fell in very much at this part. Total penetration, about 22 feet in water. Boat rather unsteady, thus rendering the angle of depression doubtful.
5	7 30	4 0	3 6	The howitzer was laid for a point immediately under the centre of 3d port, distant 54 feet.	The shell entered the water about 21 feet from the ship, struck the side a little to the left of part aimed at, and 3 ft. 6 in. below the surface of the water, penetrating through the outer plank of 4 inch fir, till it came in contact with a timber, and then dropped in the mud. Total penetration, about 21 feet through water.
6	7 30	4 0	4 0	The howitzer was laid for a point immediately under the gangway, distant 54 feet.	The shell entered the water about 21 feet from the ship, struck the side a little to the left of part aimed at, and 4 feet below the surface of the water, penetrating 3 inches into the outer plank of fir; the remaining inch was much bruised, so that the shell would doubtless have gone through the outer side altogether had it not been for a timber which was directly in front. The side fell in a good deal at this part. Total penetration, about 22 feet through water.

No. 1.—Mr. Whitworth's 24-Pounder Rifled Howitzer—*continued.*

From Mooring Lighter at "Serpent" Brig.

16 March 1858.

15. Shell were received from Mr. Whitworth fitted with "Boxer's Percussion Fuzes" for Lancaster Shells to be fired from the Rifled Howitzer against the "Serpent" brig; the howitzer was put into a mooring lighter, which was then anchored close to the vessel, and hauled in nearer as was required; this is the first trial that has taken place with these fuzes against wood from the "Excellent," the former trials being against the Needle Rocks, from "Storks'" Lancaster Gun. Not more than six rounds were fired at any one time, and the howitzer was well cleaned after each firing; the shell were scraped perfectly clean before being used; the fuzes contain 4″ of fuze composition, to ensure penetration into earth-works before bursting, and a percussion plug is fitted to each, to be screwed on in loading.

No.	Elevation or Depression.	Height above Plane.	Height of Water above Part Struck.	REMARKS.	
	° ′	*Ft. in.*	*Ft. in.*		
1	P. B.	6 6	- -	The fuze was used as supplied for service; the howitzer was pointed at that part of the counter directly under the stern post, and distant 50 yards; the lighter being right astern.	Hit; no burst, the shell passing through half a timber, and grazing another severely; it then entered the water on lower deck; the shell was found right forward on lower deck, with the plug driven in. If we suppose the percussion plug to have acted properly, still the water probably got at the composition in the fuze and put it out; outer and inner plank good (oak).
2	„	„	- -	The fuze was used as above; the howitzer was pointed direct at the stern, above upper deck, and distant 50 yards.	Hit, and burst about 100 yards beyond, thus showing that the shock was not sufficient to shake out the composition with these fuzes, and so to cause an instantaneous burst.
3	„	„	- -	The composition in fuze was all bored out, and the vacancy filled with powder, leaving the percussion plug to act by itself. The howitzer was pointed at counter, just below the stern moulding, and distant 50 yards.	Hit, and burst; some of the pieces peing picked up 18 feet inside, and others right forward on lower deck. The shell burst about 1 foot inside the ship, by the marks of the explosion, and several of the pieces were found sticking in the beam just over the hole.
4	„	„	- -	The fuze was used as above; the howitzer was pointed direct at the stern post, close to the rudder-hole, and distant about 80 feet.	Hit, and burst just inside the vessel, the shell passing through 16 inches of good oak; several pieces of the shell were found sticking in the beam, which was 4 feet from the hole; several of the pieces picked up were very small, others large.
5	„	„	- -	The fuze was used as above; the howitzer was pointed as in last round; distance 80 feet.	Hit, and burst just inside the vessel, the shell passing through 20 inches of good oak; several pieces were picked up near the hole.
6	„	„	- -	The fuze was used as above; the lighter was abreast of the vessel; the howitzer was trained about 3 points, and pointed just below the second port, so that the shell might strike the side obliquely, in order to see if the plugs were liable to be knocked out when so fired; distance, 80 feet.	Hit, and burst just inside the vessel; the shell passed through a timber partly rotten; but the inner lining of oak, and the outer planking of fir, were both good; several pieces were picked up 3 feet inside, others 12 feet.
7	„	„	- -	The fuze was used as above; the howitzer was trained about 45°, to see if the plug would be driven out in passing through; distance, 80 feet.	Hit, and burst just inside the vessel; the shell passed through a sound timber, the inner and outer planking being also good oak. Total penetration, 13 inches oak; several pieces were picked up about 3 feet inside, and a piece of fuze close to the hole.
8	5 15	„	- -	The composition in fuze was all bored out, and the vacancy filled with powder; the howitzer was pointed in the direction of the stern post, and distant 100 feet, the lighter being right astern.	No burst; the coin flew out on firing, which most probably elevated the muzzle before the shell left the gun, as it passed through the stern 3 feet above the water-line, and to do this it would only be necessary that the muzzle should be raised 2° from its former position; moreover, we have not yet had a single instance of the shell rising when fired with depression; the plug ought therefore to have acted, but even if it did, the fire might have been put out, by the plugging up of the fuze with wood, or by the water, as the shell entered the water on lower deck, immediately after passing through the stern.

No. 1.—Mr. Whitworth's 24-Pounder Rifled Howitzer—*continued.*

No.	Depression by Spirit Level.	Height above Plane.	Height of Water above Part Struck.	REMARKS.	
	° ′	*Ft. in.*	*Ft. in.*		
9	5 15	6 6	- -	The fuze was used as above. The howitzer was pointed to the left of the stern-post, and distant 100 feet.	No burst; the shell entered the water about 28 feet from the brig; it did not strike the brig, as the counter fell in so much, but entered the mud under the bottom; the shell was recovered, and the plug found to be gone, and the fuze plugged up with wood, so that it must have struck some plank or timber in the mud; but the plug must have acted, and the fire then have been put out.
10	,,	,,	3 0	The fuze was used as above. The howitzer was pointed to the right of the stern-post, and distant 100 feet.	No burst; the shell entered the water about 28 feet from the brig; it struck the stern-post 3 feet below the surface at the side, knocking a piece off 3 inches in thickness, and then fell in the mud. The velocity was thought to be scarcely sufficient to make the fuze act.
11	,,	,,	3 9	The fuze was used as above. The lighter was abreast of the vessel. The howitzer was laid for the brig, just abaft the fore-chains, and distant 100 feet; but the lump being aground, the howitzer could not be pointed direct for the vessel; the shell, therefore, struck the vessel obliquely.	No burst; the shell entered the water about 28 feet from the brig; struck end on and penetrated half an inch, and then buried itself about a foot in the mud immediately under the part struck. Percussion-plug of fuze was gone, and fuze plugged up with wood; the plug, therefore, most probably acted, but the fire was put out by the water, or the plugging up of the fuze with wood.
12	,,	,,	3 3	The fuze was used as above. The howitzer was used as in the last round; distance, 100 feet.	No burst; the shell entered the water about 28 feet from the brig; it grazed the side to the depth of half an inch, and was found in the mud, with the plug out, and the fuze knocked on one side, so that probably the plug was struck on the side, and so knocked out.
13	,,	,,	7 3	The fuze was used as above. The howitzer was pointed a little further aft; distance, 100 feet.	No burst; the shell entered the water about 28 feet from the brig; grazed about half an inch deep, at 7 ft. 3 in. below the water, and was found buried about two feet in the mud. The percussion-plug was broken at the point, and driven into the fuze; it must, therefore, have acted, and the fire afterwards put out by the water.
14	4 15	,,	3 3 to 4 3	The composition in fuze was all bored out, and the vacancy filled with powder. The howitzer was pointed as in last round; distance, 100 feet.	No burst; the shell entered the water about 15 feet from the brig; grazed the side about 3 ft. 6 in. below water-line to the depth of half an inch, and about a foot in length. It then buried itself in the mud, about 2 feet below the surface. Percussion-plug was knocked on one side, but had not apparently acted. On unscrewing the fuze, the bursting-powder was found to be caked into a solid hard mass, evidently caused by the great rotatory motion. This was also the case with all the shells that were recovered after firing, when water had not found its way into them.
15	6 30	,,	3 6	The composition in fuze was all burnt out, and the vacancy filled with fine grained powder. The howitzer was laid direct for the part immediately under the gangway, and distant 80 feet.	No burst; the shell entered the water about 22 feet from the vessel, and grazed the side at a point 3 ft. 6 in. below the surface of the water, penetrating 1½ inches; it then fell into the mud; on recovering the shell the plug was found to be gone, and the fuze plugged up with wood. The plug, therefore, most probably acted, but the fire was put out by the water, or the plugging up of the fuze with wood.
16	,,	,,	,,	The fuze was used as above. The howitzer was pointed direct, as in last round; distance, 80 feet.	No burst; the shell entered the water about 22 feet from the vessel, and grazed the side at a point 3 ft. 6 in. below the surface of the water, penetrating 1½ inches, and fell in the mud, burying itself to the depth of 6 feet. On recovering the shell the plug was found to be gone, and the fuze plugged up with wood. The plug most probably acted, but the fire might have been put out by the water, or the plugging up of the fuze.
17	6 0	,,	1 6	The fuze was used as above. The howitzer was pointed direct, as in last round; distance, 80 feet.	No burst; the shell entered the water about 18 feet from the vessel, and penetrated the outer planking of 4-inch fir, at a point 1 ft. 6 in. below the surface; it then came in contact with a good timber, passing through it, and tearing off three-fourths of it, and lodged between the lining and ship's side; the plug, therefore, must have acted, but the fire might have been put out by the water, or the plugging up of the fuze.

No. 1.—Mr. Whitworth's 24-Pounder Rifled Howitzer—*continued.*

No.	Depression by Spirit Level.	Height above Plane.	Height of Water above Part Struck.	REMARKS.	
	° ′	*Ft. in.*	*Ft. in.*		
18	6 30	6 6	3 0	The fuze was used as above. The howitzer was pointed direct for the part immediately under the port abaft the fore chains, and distant 80 feet. The loading was very hard, owing to the fouling of the bore, and the shell was obliged to be hammered home, although only three rounds had been fired since it was last cleaned.	No burst; the shell entered the water about 22 feet from the vessel, and grazed the ship's side at a point 3 feet below the surface of the water, penetrating 1½ inches, and fell in the mud, burying itself to the depth of 4½ feet; on recovering the shell, the plug was found to be gone, and the fuze plugged up with wood. The plug most probably acted, but the fire might have been put out by the water or the plugging up of the fuze.
19	6 30	„	3 3	The composition in fuze was all burnt out, and the vacancy filled with fine grained powder. The howitzer was pointed direct, as in last round, and distant 80 feet. The loading was very hard, and the shell had to be hammered home.	No burst; the shell entered the water about 22 feet from the vessel, and penetrated the outer planking of 4-inch fir, at a point 3 ft. 3 in. below the surface of the water, grazing a timber to the depth of a quarter of an inch, and lodged between the lining and the side. The plug most probably acted, but the fire might have been put out by the water, or the plugging up of the fuze.
20	6 0	„	2 6	The fuze was used as above. The howitzer was pointed direct, as in last round, and distant 80 feet. The loading was so difficult, that it was not considered safe to go on firing after this round, till the howitzer should be cleaned.	No burst; the shell entered the water about 18 feet from the vessel, and penetrated the outer planking of 4-inch fir, at a point 2 ft. 6 in. below the surface of the water, making a hole in it 1 ft. 6 in. in length, being turned downwards by a bolt and lodged in the side. The plug was gone, and the fuze plugged up with wood, but the plug must have acted, and then the fire was most probably put out by the water or the plugging up of the fuze.
21	5 30	„	1 0	The fuze was used as above. The howitzer was pointed direct, and for a part immediately under after part of main chains. Distance, 80 feet.	No burst; the shell entered the water about 13 feet from the vessel, passed through the side, between timbers, at a point 1 foot below the surface of the water, knocking away a portion of after bulkhead of magazine; it was then canted up and struck the combings of after companion, 5 inches thick, knocking away a portion of it, and then went overboard and fell in mud 20 yards beyond. The plug was found driven into the fuze and plugged up with wood, so that it must have acted, and the fuze have been put out by the water.
22	5 45	„	2 0	The fuze was used as above. The howitzer was pointed direct, and a little to the right of the last round. Distance, 80 feet.	No burst; the shell entered the water about 16 feet from the vessel, grazed the side at a point 2 feet below the surface of the water, penetrating to a depth of 2 inches, and then fell in the mud. On recovering the shell, the plug was gone, and the fuze plugged up with wood. The plug, therefore, must have acted, and the fire was afterwards put out by the water.
23	5 30	„	1 8	The fuze was used as above. The howitzer was pointed a little to the left of the two last rounds. Distance, 80 feet. Diameter of vent ·233.	No burst; the shell entered the water about 13 feet from the vessel, passed through the side and timber at a point 1 ft. 8 in. below the surface of the water, and fell in store-room close abaft magazine. The plug was found driven into the fuze, and plugged up with wood. Total penetration through oak 13 inches.

App. No. 28.

— No. 2. —

Mr. Whitworth's 68-Pounder Rifled Gun.

H.M.S. "Excellent."
8 October 1858.

Experimental firing with Mr. Whitworth's 68-pounder rifled gun, received September 20th, against 4-inch common iron plates attached to the side of H.M.S. "Alfred," forming a target 13 ft. broad by 10 ft. high. The vessel was moored as before, in the 1,400 yard creek, and the firing took place from the "Stork" gunboat nearly on an even keel. The plates were those that had not been struck in the previous experiment; they were 13 ft. in length and 1 ft. 9 in. in breadth.

The gun was of the same form and dimensions as the service 68-pounder, 95 cwt., but somewhat heavier, owing to the bore being smaller. It was rifled in the same manner as the 24-pounder howitzer, as described in former report (see page 168) but the turn was 1 in 100 inches, and the windage on the going in half sides was one-thirtieth of an inch. Diameter of bore from face to face 5 in., from angle to angle 5½ in.

The projectiles were of solid cast and wrought iron, some of the latter being hardened; they weighed 68 lbs. and measured 12·7 in. and 11·7 in. in length respectively, 4·7 in. in diameter at the point, and 5 in. at the base.

One round was fired from the platform to obtain the range. The shot fell direct at 450 yards and ricochetted on to 1,650 yards; it deflected considerably to the left "en ricochet," at least 200 yards.

Tangent sight elevation for 450 yards was found to be $\frac{5}{8}°$.

No.	Gun.	Projectile.	Charge.	Distance.	Indentation.	REMARKS.
			Lbs.	*Yds.*	*In.*	
1	68-pounder, Whitworth.	Cast-iron shot, numbered 9.	10	350	$\frac{5}{8}$	Hit direct, end on, but very obliquely; leaving an impression of the side of the shot on the plate: 12 of the bolts (in the plate struck) were started out from 1¾ in. to a quarter of an inch. Two cracks observed, one right across the plate, 7½ ft. to the right of indentation; and another, 14 in. in length, 2 ft. to the right of indentation, extending from the top of the plate across a bolt. Woodwork inside on lower deck slightly shaken, and a few treenails started. Shot broke up. Gun did not recoil taut breech.
	Loading very difficult. Greatest bulge of plate inwards, 1⅜ in. Diameter of indentation, 4 in.					
2	68-pounder, Whitworth.	Wrought-iron shot.	10	350	–	Fell short and ricochetted through the side on main deck, to the right of the iron plates, passed through a timber, tearing out the inner lining considerably; it then struck and broke an iron knee on the opposite side, and cut half through the shelf piece, falling inboard spent. Recoil very moderate, as before.
	Loading very difficult.					
3	68-pounder, Whitworth.	Wrought-iron shot.	10	350	–	The shot jammed in loading, and could not be rammed home, although great force was applied, till water was poured down the muzzle; the charge was thus drowned, and the shot afterwards rammed home, and then blown out in the water. Time taken up in clearing the gun 1½ hours. Found it necessary to wash the gun out each round to facilitate the loading. Recoil very moderate, as before.
4	„	Cast-iron shot, numbered 11.	„	400	1	Hit direct, end on, but very obliquely, at the lower edge of a plate: 4 bolts were started outwards from the plate about half-an-inch. One crack 8 in. to the right of indentation, 7 in. in length, extending to the bottom of plate. Recoil very moderate, as before.
	Loading easier. Greatest bulge of plate, ⅞ in. Diameter of indentation, 5 in.					
5	68-pounder, Whitworth.	Wrought-iron shot.	12	450	–	Hit direct, and passed right through the plate and ship's side, making a round hole in the plate 6 in. in diameter, tearing off the parts in four layers, as if the plate was badly welded, and punching out a piece 2 in. thick and 5⅛ in. diameter; also another irregular piece 4½ in. by 3½ in. and 1¾ in. thick, driving them through the side on to the orlop deck: they were found about 4 ft. from the hole. The shot passed through the side between timbers, coming in contact with the after-part of the end of an orlop beam, which it scored to a depth of 4 in.; it then grazed the under side of lower deck, and fell inboard, spent, about 2 ft. from the hole. The shot thus passed through 4 in. of iron, and the outer planking (6 or 7 in. oak): there was no inner lining. The end of the shot was much bruised and opened. The shot was found to be imperfect on loading, being starred at the point. Recoil very moderate, as before.
	Loading easy.					

2.—Mr. Whitworth's 68-Pounder Rifled Gun—*continued.*

No.	Gun.	Projectile.	Charge.	Distance.	Indentation.	REMARKS.
			Lbs.	*Yds.*	*In.*	
6	68-pounder, Whitworth	Cast-iron shot, numbered 10.	12	400	1⅛	Hit direct, end on; 4 bolts were started out about half an inch. Four cracks made, two right across the plate, one of them being 2 ft. 1 in. to the right, and the other 2 ft. 4 in. to the left of indentation. The third crack was 17 in. in length, proceeding from a bolt, and 20 in. to the left of indentation. The fourth crack was close to the indentation, 5 in. in length. No injury inboard. Shot broke up. Recoil very moderate, as before.
		Loading easy.				
7	- „ -	Cast-iron shot, numbered 27.	–	–	–	The gun burst with great violence, some parts of it cutting away the fore and main masts, and knocking a large piece out of the funnel. The greater part of the gun was blown overboard, leaving pieces of the breech only about the carriage, which was also much shattered. No one hurt. Recoil very moderate, as before. The following is the weight of the pieces that remained:—A piece of breech, 5¾ cwt.; under part of first reinforce, 12¼ cwt.; ditto of second reinforce and trunnions, 10½ cwt.; a small piece, ¾ cwt.: total weight, 28¾ cwt. A cap square was afterwards picked up on the mud 100 yards to the right of where the "Stork" lay.

General Remark.—One-half of the shot was afterwards picked up at a distance of about 800 yards from the "Stork," and directly in the line of fire. From the appearance of the shot at the broken part, it was thought that the cause of the bursting of the gun was not owing to any flaw in the gun itself, but to the severe twist of the bore, and the little or no windage that is allowed as the shot leaves the gun, the shot being bent at the point where it broke, and appearing to have been forced partly out of the rifling instead of following the twist of the bore, or else it must have been jammed in coming out. The latter was, most probably, the real cause, as, owing to the half sides of the shot, which bear on the gun in coming out, not bearing as the shot is rammed home, any irregularities on these half-sides, or on that part of the bore upon which they bear, would not be discerned in the course of loading, but only by the jamming of the shot in the bore in coming out.

— No. 3. —

Trial of Armstrong's Breech-loading Rifled Gun.

22 February 1859.

Proceeded this day in H. M. gunboat "Stork" to Spithead, for the purpose of noting the recoil when the gun is fired with the vessel rolling or heeling.

The carriage was fitted on to a common pivot slide with side compressors, as with a common pivot gun-carriage, and a bolt to the fore part of the slide, so that the carriage could be pivoted to the slide when it was desired to fire on "non-recoil," or it could recoil on the slide like any pivot gun. The carriage was in two parts, the lower part being an inclined plane at an angle of 22 deg. for the other to run up when the gun recoils on firing. The upper part was fitted also with a compressor, so that the recoil on inclined plane might be lessened at pleasure. The gun is supposed to run up the plane after firing, and then run down again to its position. The gun was elevated by a screw attached to the under part of breech which allowed of the guns receiving 10 deg. elevation, and the fore part of carriage admitted of 5½ deg. depression.

Time for giving gun extreme elevation from extreme depression with two men 1 min. 2 sec., with one man 38 sec. Time for giving gun extreme depression from extreme elevation with two men 1 min. 14 sec., with one man 1 min. 24 sec.

The shot were of cast iron, cylindro-conical in form, with a coating of lead one-eighth of an inch thick on the outside, extending from the base to within four inches of the point.

Total length of gun - -	10 ft.
Length of bore - - -	8 ft. 11 in.
Weight - - - -	26 cwt.

The turn was 1 in about 40 ft.

Length of chamber for powder -	14 in.
Diameter of bore - - -	4 in.
No. of grooves - - -	50
Length of projectile - -	11 in.
Weight - - - - -	32 lbs.
Diameter of breech - - -	14·7 in.
Thickness „ - - -	4·9 „
Diameter of muzzle - -	7 „
Thickness „ - - -	1·5 „

App. No. 28.

3.—TRIAL of Armstrong's Breech-loading Rifled Gun—*continued.*

No.	Charge.	Elevation.	Heel.	REMARKS.
	Lbs.		*Degrees.*	
1	4	P. B. in carriage.	1	The gun was fired as a weather gun, with the slide and carriage compressors taut. Carriage not pivoted to slide. Recoil on inclined plane, 13¾ inches. Ditto - slide - - - 6 „ Carriage did not run down inclined plane after recoil, but had to be pushed down.
2	„	„	½	Fired as a weather gun; carriage compressor somewhat slackened, side ones taut. Recoil on inclined plane, 1 ft. 11¾ in. Ditto - slide - - - - - ½ in. Gun had to be pushed down the plane after recoil.
3	„	„	0	Carriage pivoted to the slide, slide compressors let go, also the carriage compressors. Gun recoiled on the plane, 2 ft. 2 in. and then ran down to its position.
4	„	„	0	Fired in the same manner as the last. Gun recoiled on plane 21½ in. and ran down to its position.
5	„	„	½	Carriage not pivoted to slide, slide compressor set up taut, carriage compressor slack. Fired as a weather gun. Gun recoiled on the plane 22, and ran down again. No recoil on slide.
6	5	„	3	Fired as a lee gun in the same manner as above. Gun recoiled on plane, 2 ft. 1 in. and ran down again. No recoil on slide. A 6 lb. charge was tried, but found too long.
7	„	„	„	Fired as a weather gun, carriage not pivoted to slide, carriage compressors slack, side ones taut. Gun recoiled on plane, 2 ft. 5 in. and ran down again. No recoil on slide. Sail was made on the vessel to increase the heel.
8	„	„	„	Fired as a weather gun in the same manner as the last. Recoil on plane, 2 ft. 5½ in.; the gun hung for a few seconds till vessel came on even keel, and then ran down again.
9	„	„	4	Fired as a weather gun, compressors on slide, and carriage let go. Recoil on plane, 1 ft. Ditto - slide 4 ft. 4 in., gun ran down again.
10	4	Extreme elevation in carriage.	5¼	Carriage pivoted to slide for "non recoil." Fired as a weather gun, carriage compressors taut. Recoil on plane, 20 inches. Gun hung after recoil, but was easily pushed down again.
11	6	„	–	Fired as a weather gun as the last, but carriage compressors slack. Recoil on plane 2 ft. 1½ in., gun ran down again to its position. Time of flight, 18¼ sec.; some difficulty in getting 6 lb. charge home.
12	„	„	5½	Fired as a weather gun as before; same difficulty in loading. Recoil on plane, 2 ft. 0½ in. Gun ran down again easy: flight, 18½ sec.
13	„	„	5½	Fired as a weather gun as before. Recoil on plane, 2 ft. 6½ in. Gun hung after recoil, but was easily pushed down; flight, 19 sec.
14	„	„	5	Fired as a weather gun; carriage pivoted to slide, carriage compressors slack. Recoil on plane, 2 ft. 8 in. extreme. Gun hung after recoil, but was easily pushed down; flight, 8 sec.
15	„	P. B. in carriage.	5	Fired as a weather gun as before. Recoil on plane, 2 ft. 6½ in., gun ran down again; flight, 7¾ sec.

3.—Trial of Armstrong's Breech-loading Rifled Gun—*continued.*

No.	Charge.	Elevation.	Heel.	REMARKS.
	Lbs.		*Degrees.*	
16	6	P. B. in carriage.	5	Fired as a weather gun; gun came up to extreme recoil with force, and then ran down again; it was considered that there ought to be some elastic substance at the rear part of inclined plane, in the same manner as at the fore part, to lessen the shock of recoil.
17	„	Extreme depression.	5½	Fired as a weather gun; gun came up to extreme recoil with considerable force, and ran down again.
18	„	- „ -	5¾	Fired as a weather gun; gun recoiled with force as before, and then ran down again. A shake discovered in the fore part of upper carriage, caused by recoil.
19	„	- „ -	4¼	Fired as a weather gun; carriage compressors tautened a little; gun recoiled with force as before, but was easily pushed down; the recoil shook the fore part of carriage so much, that it was considered advisable to discontinue the practice of firing on this plan.
20	„	- „ -	4¼	Fired as a weather gun; carriage compressors as before, slide compressors taut, carriage not pivoted to slide, gun recoiled to full extent, but not with quite so much force, and ran down again. Recoil on slide, half an inch.
21	„	- „ -	4½	Fired as a weather gun; carriage not pivoted to slide, all compressors slack. Gun recoiled to full extent, and ran down again. Recoil on slide, 4 ft. 2 in.
22	„	„ -	6½	Fired as a lee gun; carriage pivoted to slide for "non-recoil," all compressors slack. Recoil on plane, 21 inches; gun ran down again; shot did not penetrate under water, but ricochetted on for a short distance, and fell spent.
23	„	- „ -	5¼	Fired as a lee gun, in the same manner as the last. Recoil on plane, 2 ft. 3½ in. Gun ran down again.
24	–	Horizontal by sight.	6	Fired as a lee gun as before. Recoil on plane, 2 ft. 2 in. Gun ran down again.
25	„	- „ -	7	Fired as a lee gun; carriage not pivoted to slide; all compressors slack. Recoil on plane, 10½ inches. Ditto - slide 17½ „ Gun ran down.

24 February 1859.

Firing from platform battery, abreast of "Excellent," to see if the shot would penetrate under water, when fired with considerable depression. The gun was mounted on a 40 cwt. 32-pounder common carriage, and fired as under, at an oak butt, distant 30 yards from the gun. The butt was 10 ft. by 9 ft. constructed of 14-inch fir piles driven close together, and covered on each face with 4-inch oak-planking, thus making in all 22 inches of solid wood.

No.	Charge.	Depression by Spirit Level.	Height above Plane.	Height of Water above part Aimed at.	REMARKS.
	Lbs.	*Deg. Min.*	*Feet.*	*Feet. In.*	
26	4	7 30	10	2 0	The shot struck the water about 15 feet from the butt; rose and lodged in the middle of a pile, 2 ft. 9 in. above the water, thus passing through 4 inches of oak, and 10 inches of fir.
27	6	8 0	„	3 0	The shot struck the water about 16 feet from the butt, rose and struck broadside on, 1 foot above the water, merely indenting the wood, and fell in the water; it was afterwards recovered; the rifling was very distinct and regular.
28	6	7 0	„	1 6	The shot struck the water about 14 feet from the butt, rose and passed through the butt, two feet above the water.

App. No. 28.

3.—Trial of Armstrong's Breech-loading Rifled Gun—*continued.*

At Spithead, 25 February 1859.

The gun this day was mounted on its proper carriage and slide, as fitted by Mr. Armstrong, having a traversing motion attached to it, which enabled the gun to be trained either way by one man. The slide was, however, fitted at Gun Wharf, with a flap in the fore and after part for the purpose of shifting the position of the gun when necessary, the carriage being pivoted to the fore part of the slide. Height of dispart above the deck, 5 ft. 3 in.

No.	Charge.	Elevation.	Heel.	REMARKS.
	Lbs.		*Degrees.*	
29	6	Extreme depression.	4¼	Fired as a weather gun; carriage compressors moderately taut; gun recoiled full extent on inclined plane, with force, and hung, but was easily pushed down again.
30	„	- „ -	3	Fired as a weather gun; carriage compressors moderately taut; gun recoiled to full extent on plane, but easier, and then ran down again to its position.
31	„	- „ -	2	Fired as a weather gun; carriage compressors moderately taut; gun recoiled to full extent as before, and ran down again.
32	„	- „ -	1	Fired as a weather gun; carriage compressors quite taut; gun recoiled on plane 2 feet, and then ran down again.
33	„	P.B. in carriage.	3	Fired as a weather gun; carriage compressors taut; gun recoiled on plane 20 inches, and ran down again.
34	„	Extreme depression.	3	Fired as a weather gun; carriage compressors much tauter; gun recoiled on plane 26½ inches, and ran down again.
35	„	2°	0	Compressors as in last round; gun recoiled on plane 2 feet 2 inches, and hung, but was easily pushed down after slacking compressors.
36	„	Extreme depression.	0	Carriage compressors quite taut; gun recoiled on plane 2 feet, and ran down again.
37	„	P. B.	0	Carriage compressors quite taut; gun recoiled on plane 20 inches, and ran down again.

From this day's as well as from the previous trials, it was concluded that the carriage compressor materially lessons the recoil when set up quite taut, but it becomes a question whether the angle of inclination of the plane for recoil should not be increased, as when the axis of the piece was brought more in a line with the inclined plane by extreme depression which would frequently be the case with weather guns at sea; the gun frequently recoils to full extent, and with force sufficient to start the fore part of the carriage, but this might have been prevented by allowing the whole carriage to recoil upon the slide.

Handles are required for working the carriage compressors instead of the present method of turning the screw by a wrench; and the gun is mounted too high for ship purposes, as the captain of the gun cannot conveniently look along the sights.

The smallness of the chamber renders the loading somewhat difficult with the higher charge, as it has to be made to a great nicety to insure its going home.

— No. 4. —

Account of the Trial of Two Armstrong Guns on board H. M. S. "Wrangler," off *Harwich*, commencing on Monday, 21st of November 1859.

H. M. S. "Wrangler," off Harwich,
21 November 1859.

The following is a description of the guns.

The one of 6-inch calibre, length 17 diameters, and weight 65 cwt., intended to throw a 70 lb. projectile with a charge of 8¾ lbs. was mounted on an ordinary 68-pounder slide carriage, having holes cut in the brackets for the breeching to reeve through.

This gun had the hole for vent-piece at the side of the breech covered with a metal shutter to prevent inconvenience to the gun's crew from the escape of gas.

The other of 4¼-inch calibre, length 25 diameters, and weight 26 cwt., intended to throw a 32 lb. projectile with a charge of 4 lbs., was mounted upon a carriage invented by Sir William Armstrong; this carriage was in two parts, the lower part, which rested upon a pivot slide, being simply an incline of about 22 deg., up which the upper part was intended to recoil on the gun being fired,

fired, and to slide down again by its own weight. An apparatus for training by means of a friction roller under the slide, worked with an endless screw, was also fitted to this carriage.

This gun had a hole to receive vent-piece at top of breech, which was left uncovered. The twist of the rifling in both guns is one turn in 38 diameters. The trial, which was conducted under the superintendence of Captain Sir William Wiseman, proceeded as follows :—

Two rounds were first fired from the 70-pounder, with a view of ascertaining whether the shutter that has been fitted to prevent the escape of gas from being blown out in the direction of the men working the gun, was effective; 100 lb. shot was fired with a 10 lb. charge of the A. R. M. powder; a piece of canvas was hung loosely over the shutter. The gas passing through the upper edge of the shutter through the canvas over the gun, without breaking the yarns with which it was fastened, leaving a black deposit on the surface of the canvas without burning it. On opening the shutter a very considerable deposit in thin black flakes was observed to be left on the whole interior space around the vent piece; the gas had also passed through the lower edge of the shutter, leaving a deposit on bed and rear chock. No escape took place that could in any way injure the men working the gun.

Six rounds were then fired from the 32-pounder at a target laid out at 2,000 yards, the roll of the ship averaging four or five degrees each way; the practice was good; all the shot pitching sufficiently near the target to have hit a frigate.

The upper carriage, probably owing to a thick coating of new paint, stuck to the incline after the recoil, and required to be forced down by hand. The apparatus for training which was used appeared to act fairly; though some assistance from the gun's crew was required to give the requisite training. The only tackles used were the two traversing tackles, and these only for the purpose of getting the general direction; the traversing screw being used for all small degrees of training.

Two rounds were then fired at the same target from the 70-pounder, using 10 lb. charges and 100 lb. shot. The practice was good, and the gun, which was held by both outside and inside compressors, did not tauten the breeching by its recoil.

The escape of gas was not such as to cause any inconvenience to the gun's crew, and no apparent injury was done to the carriage by the firing. The concussion in both cases threw the small coin out with considerable force to the opposite side of the deck. As far as the experiment has gone, both carriages have done all that could be expected from them; it must be remembered, however, that the old pattern carriage upon which the 70-pounder is mounted, was worked by 16 men, whilst the 32-pounder mounted upon the carriage suggested by Sir William Armstrong, was worked by six men.

The firing was continued on the following morning, the wind being very light and the water smooth. A target was laid out as before at 2,000 yards, and 10 rounds were fired at it from the 70-pounder gun, using 10 lb. charges and 100 lb. shot.

The firing was extremely good, all the shot pitching close round the target. The gun was worked very easily by a crew of 16 men. The 100 lb. projectile, which was brought up by two men on a bearer constructed for the purpose, was handled with perfect ease, and the whole practice tended to show that the gun would be worked with ease whenever the ordinary pivot-guns now in the service would be available. The recoil was never violent, and when both outside and inside compressors were used, was not sufficient to tauten the breeching. It was ascertained from this trial, that with the above-mentioned crew the gun could be run out during the process of loading. After the eighth round which was fired on this occasion, the shutter for covering the opening at side of breech stuck fast from the large amount of deposit that had collected under the rings on which it worked, and required to be forced down into its place with a handspike. A thick fog, which came on in the afternoon, prevented the continuation of the firing for this day.

App. No. 28.

Wednesday, 23 November 1859.

The weather still continued fine, with a very light breeze and smooth water; it was necessary, in order to test the efficiency of the carriages, to give the ship a list by moving her weights; by this means, a heel, varying from three degrees to five degrees, was obtained.

Five rounds were fired from the 70-pounder as a lee gun, using the 70 lb. shot, and 8¾ lbs. charge, the gun being laid horizontal, and no object pointed at, principally with a view of ascertaining the quickness of firing. Owing to delay occasioned by the cartridges having been made too large, and thus causing a difficulty in loading, it took nearly five minutes from the order to load till the last round was fired. The same thing was then again tried, and the five rounds were fired in 3′ 10″, the same difficulty being still experienced in loading. One round was afterwards fired without closing the shutter for preventing the escape of gas, and a piece of canvas was fastened over the opening. The gas blew the canvas away with great force and slightly burnt it.

The 32-pounder was next tried with a crew of 6 men, and 5 rounds were fired from it as a lee gun in 3′ 6″; 4 lb. charges were used without pointing at an object, and without using a sponge; the recoil was easy, the gun slipped down to its original position immediately the compressors were slackened.

The gun was then shifted to the weather side of the ship, and 5 rounds fired from it in this position. In this case, the inclination of the plane of recoil being reduced by the heel of the ship, the gun did not slide down to its position of firing, on slacking compressors after recoil, but required considerable force to be used to cause it to do so. This, however, was probably owing in a great measure to the carriage being new, and the plane upon which the upper part of it recoiled having been thickly coated with paint.

One round was then fired from the 32-pounder, with the flap of the bolt upon which the carriage pivots on the slide removed, the friction of the carriage on its slide being the only action in opposition to the recoil. An outside compressor was left on to prevent the carriage from recoiling off the slide, but was not set up. The carriage recoiled without violence till brought up by the compressor. As it was found impossible to give the ship the list that was required to test the efficiency of the carriages by moving her weights, the slides were chocked up till that of the 70-pounder formed an angle of 8 deg. with the horizon, and that of the 32-pounder 8½ deg., and secured firmly in that position.

App. No 28.

Five rounds were next fired from the 32-pounder, in the two first the gun being laid parallel to the slide, and in the remaining three being laid horizontal. In the first two rounds, the recoil arrangement answered perfectly, the gun sliding down on slacking the compressors.

In the last three, the gun had to be forced down the incline. The 70-pounder being chocked up as above mentioned, and laid parallel to the slide, was then fired as follows:—

1st. A round was fired with a 70 lb. shot, and 8¾ lb. charge, all compressors being set up, when the recoil was not sufficient to tauten the breeching.

2dly. With 100 lbs. shot and 8¾ lbs. charge, with a similar result; and,

3dly. With 100 lbs. shot and 10 lbs. charge, when the gun recoiled with considerable force, though not greater than that observed with the service 68-pounder, when using a distant charge.

H.M.S. "Wrangler," off Deal,
24th November 1859.

A TARGET was moored at the edge of the Goodwin Sands, and a position was taken up by the gun-boat at a distance of 2,000 yards from it; 10 rounds were fired from the 70-pounder, and six from the 32-pounder; but owing to a strong tide that was running, which caused the target to drift, and the gun-boat to continually alter her position, it was almost impossible to estimate the distance sufficiently accurately to make very good practice at so small an object.

The ship during the practice was rolling quickly from four to six degrees each way. The target having drifted on the sands, the firing was continued without pointing at an object, with a view of further testing the efficiency of the carriages in a sea-way.

The rolling motion at this time having increased to eight degrees each way, nothing during this day's practice occurred to alter the conclusion which the firing of the three previous days had led to—namely, that the gun could be worked on all occasions when the ordinary service guns are available.

On this occasion, both guns worked with perfect ease with reduced crews; that for the 32-pounder consisting only of four men, and that for the 70-pounder, of 11 men; with this crew it was not found practicable to run the 70-pounder out during the time of loading, so that the firing could not be carried on so rapidly as it could with a larger number.

Throughout the practice with the 70-pounder no difficulty of importance occurred in working the gun or in handling the projectiles.

The escape of gas was never so great as to be seriously inconvenient to the gun's crew, and the recoil was not violent, even when fired as a weather gun, heeling over eight degrees.

It seems, however, that the steps of the carriage upon which the handspikes work for the elevation are capable of being lengthened about four inches, without interfering with the arrangement for working the shutters, and it appears that an increase of length here would be an advantage, both for giving the handspikes a firmer hold upon the carriage, and for giving additional strength to the carriage itself.

The plan for having the opening for vent-piece at the side in the larger guns, though apparently rendered necessary by its weight, being more than could be conveniently lifted by hand, was found objectionable on the following grounds:—

1st. The shutter that covered the hole and prevented the escape of gas from burning the men working the gun, was found to stick fast after about 10 or 12 rounds, and great force was necessary to be used in moving it.

2d. The escape of gas being turned off by the shutter partly upwards and partly downwards, in the direction of bed, coin, and slide; these were soon covered with the deposit from the powder, making them extremely slippery, and rendering a continual supply of sand over the slippery parts necessary, to keep the coin in its place even while the gun was stationary, also making the steps of the carriage so greasy that the handspikes were sometimes used with difficulty.

3d. With this arrangement the vent-piece does not find its own place in rear of the chamber, but depends upon the carefulness of the man whose duty it is to place it for the accuracy of its position: this, in the hurry of action, might be neglected; or, in the event of casualties, might become the duty of a man who did not understand it; the result being that the vent-piece would be blown out in the direction of the gun's crew, which could not occur without loss of life.

In the carriage for the 32-pounder the arrangement for recoil was not completely effective, especially when used as a weather gun, as it often stuck fast to the top of the incline, and required considerable force to cause it to slide down to its position for firing. The arrangement for the final adjustment of direction interferes with the elevation, and would seldom be made use of, except in perfectly smooth water and at anchor. The gun, when mounted on this carriage, owing partly to the above-named traversing arrangement, and partly to the exceedingly low position of the trunnions, is not capable of receiving more than five or six degrees of elevation.

With these exceptions the carriage answered perfectly, and there appeared to be no reason why it should not, with certain modifications, be generally adopted for this description of gun.

In order to adapt as nearly as possible the positions and numbers that had been in vogue with the muzzle-loading guns, the crew for the 70-pounder were assembled in the usual manner; with this exception, the numbering took place from the breech of the gun towards the ship's side, instead of from the ship's side towards the breech.

COPIES from SECOND EXPERIMENT BOOK, commencing 5 July 1860.

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App. No. 28.

— No. 1. —

	lbs.
Weight of Armstrong's carriage without slide - - - -	558½
Weight of common carriage - - - - - - -	295
Weight of recoil apparatus - - - - - - -	36½
Total weight - - -	331½

Her Majesty's ship "Excellent," 5 July 1860.

Trial of Boats' Carriages for Armstrong Guns, fitted for non-recoil.

An iron bar, with an eye at one end, was fixed in a fore and aft position in the slotway in centre of the slide underneath the carriage, the eye at the end of the bar being secured to the solid wood in forepart of the slide by an iron bolt, which passed transversely through it, and through the forepart of the slide. A stout iron ring, with a short arm projecting from its upper edge, was fitted on to the iron bar, and was free to travel on it; the short projecting arm passing through the solid wood connecting the brackets of the carriage, and secured there by a screw-nut. In front of the traveller, filling up the space between it and the standing part of fore and aft bolt, was fitted three broad india-rubber rings, with washers of metal between each; and in rear of the traveller, six similar india-rubber rings, with washers of metal between each, filled up the remaining space on the bolt, the last washer being secured in its place by a screw-nut: on the edges of the last washer are two shoulders, which fit into grooves on each side of the slotway, and prevent the after end of the fore and aft bar from drooping. The carriage is then allowed to recoil as far as the compressibility of the six india-rubber rings in rear of the traveller will allow, their elasticity causing it to replace itself after firing, the shock of the rebound being received upon the india-rubber rings in front of the traveller.

In other respects, the carriage and slide were the same as those usually supplied for boats' service, with holes cut in the brackets for the breeching to reeve through when the non-recoil apparatus is disconnected; so that in the event ef the non-recoil apparatus being injured, the carriage could be used, on the ordinary recoil principle, by merely removing the transverse bolt which passes through the eye at the end of the bolt containing the indiarubber rings.

Account of Firing.

Fifteen rounds were fired, with 4½° elevation, and 1½ lb. charges, from the Armstrong 12-pounder, the extent of recoil being measured after each round, which did not perceptibly alter during the firing. The recoil appeared very violent, the compression of the india-rubber rings only taking place to the extent of 10 inches, the carriage replacing itself with considerable force after recoil. The jar caused the rear part of the slide to jump some inches from the thwart it rested on. On removing the transverse bolt,. it appeared to be very slightly bent. The non-recoil apparatus was then removed, and two rounds were fired, using the ordinary compressor, the gun, coming into a taut, breeching each round without any unusual violence.

In the first round, the recoil allowed by the breeching was 3 feet 2 inches; and in the second, the breeching was shortened up, allowing a recoil of 2 feet 4 inches.

The apparatus for recoil was then reconnected, and the trial continued. The ordinary compressor for boats' guns was used, and set up as taut as possible each round; no breeching was used.

Five rounds were fired, the gun recoiling with great violence and replacing itself.

A sandbag was then placed under the rear part of the slide, raising it six inches from the thwart, and giving the slide an inclination of 3½ degrees. Seven rounds were fired from the gun in this position, when the violence of the recoil was considerably diminished, and did not appear excessive.

The sandbag was then removed, and the slide allowed to rest on the thwart.

Three rounds were then fired in this position, when the increased violence of the recoil was quite perceptible. The compression of the six india-rubber rings on rear part of bar allowed a recoil of 10 inches in all cases, and the reaction caused a compression, on the three rings on forepart of bar, to the extent of 1·8 inches; that is, the gun recoiled 10 inches, then rebounded 11·8 inches, and again recoiled 1·8 inches. It is probable that, by increasing the length of the bar and the number of the indiarubber rings, the excessive violence of recoil might be reduced sufficiently to make this plan of recoil answer satisfactorily.

— No. 2. —

Her Majesty's Ship "Excellent," 28 June 1860.

TRIAL of a 12-Pounder Armstrong Gun mounted on a Boat's Carriage fitted on Sir William Armstrong's plan, in which the upper part of the Carriage is allowed to recoil up an incline, and to slide down by its own weight to the position of firing immediately afterwards.

THREE indiarubber buffers were placed at the bottom of the incline, to receive the shock occasioned by the gun sliding down again after firing.

The compressor used was one fitted on the same principle as the inside compressors for pivot guns.

The carriage was adapted for the use either of an elevating screw or bed and coin.

The five following rounds were fired with 4° 50′ elevation, and 1½ lb. charge, using the elevating screw:—

1st.—With breeching made fast and compressor set up, the gun recoiled to a taut breech, about 1½ feet up the incline; and after slacking compressor, considerable force was required to force it down the incline again.

The breeching was then unrove and kept so during the experiment.

2d.—Compressor set up.

Recoiled to a distance of eight inches from top of incline, and required to be forced down after slacking compressor.

3d & 4th.—Compressor slack.

Gun recoiled to the top of incline, and replaced itself. One of the buffers at bottom of incline was thrown off; recoil appeared violent.

5th.—Compressor set up as taut as possible.

Gun recoiled to within eight inches of the top of incline, requiring to be forced down again after slacking compressor.

Her Majesty's Ship "Excellent," 18 July 1860.

TRIAL of Armstrong's Boats' Carriage continued.

Before commencing the firing, a crack was observed on the shoulder against which the carriage is brought up when at the top of incline.

Five rounds were fired, with compressor set up as taut as possible. The gun in each case recoiled smartly to a point about eight inches from the top of incline, where it was brought up by the compressor. After slacking compressor, considerable force was required to cause the gun to slide down again.

Two of the indiarubber buffers came off during the firing.

(1.)—Three rounds were then fired without using the compressor. The gun in each case recoiled with considerable force to the top of incline and replaced itself. One of the buffers came off during the firing.

Five rounds were then fired with the compressor slack, the gun recoiling to the top of incline and replacing itself. No increase was observed in the crack of shoulder at the top of incline. One of the buffers at the bottom of incline came off during the firing.

(2.)—The elevating screw was then taken out, and the bed and coin substituted.

Two rounds were fired with compressor set up. The gun recoiled smartly to a distance of 12 inches from the top of incline, and required to be forced down again after slacking compressor.

The latter carriage appears to be open to the following objections:—

1st.—Its increased weight as compared with other boats' carriages; the extra amount of gear connected with it; the nicety of its fittings; and, generally, the fact of its being more complicated, and consequently difficult to keep in order, than other carriages.

Some of these objections are perhaps, to a certain extent, inseparable from any non-recoil plan that could be devised; they appear, however, to exist to a greater extent than in the one in which the recoil is received by the compression of indiarubber rings.

2d.—The large amount of ironwork necessary to allow the gun to recoil up the incline, while resting on its elevating screw, would cause an increased number of splinters if the carriage were struck by a shot in action.

3d.—The difficulty frequently found in causing the gun to slide down its incline after slacking the compressor.

4th.—The great height to which the gun is raised when at the top of the incline would, in addition to increasing the size of the mark for an enemy to fire at, be likely, if used in a seaway, to capsize the gun, or at all events to cause undue strain upon the bolts, slide, and fighting-thwarts.

Beds and coins appear to be inapplicable for boats' guns for the following reasons:—

1st.—With carriages so fitted the gun must be elevated, either by handspikes or by lifting the breech by hand. The space in the bow of a boat is too cramped for the former, and the latter plan is obviously objectionable on account of the man who elevates being in the way of the captain of the gun taking his sight.

2d.—Elevating by coin entails the necessity of one or two more hands than are required for using the elevating screw.

3d.—Boats' guns being generally used in a fore-and-aft position, their elevation is not materially affected by the heel; the alteration necessary in the elevation of the gun will therefore be such as can be given very quickly with the elevating screw, which is in every respect much more handy for boats' service.

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— No. 3. —

Her Majesty's Ship "Excellent," 13 October 1860.

TRIAL of an Armstrong Carriage, in which the elevation is given by means of steps on the side-plates for the bed to rest upon; the bed having two arms projecting at each side to fit into the steps at the side-plates, and secured in that position by lanyards passing round the bed-bolt, and back to the cleats on the side of bed. Five-pound charges and solid shot were used, the carriage being secured to the fighting-bolt in forepart of slide.

No.	Elevation.	REMARKS.
1	P. B.	- - Bed lanyards made fast and compressor set up. The bed did not start; small coin flew out; gun recoiled 2 feet 3 inches, and required to be forced down, after slacking compressor. On this occasion the compressor lever having been turned round a little too far in slacking, was jammed inside the brackets after the gun had slid down, and had to be taken off and replaced before the gun could be fired again. As it appeared evident that, with the present form of coin and means of securing it, nothing could prevent its flying out every time the gun was fired, it was not used during the following rounds.
2	P. B.	- - Bed lanyards let go, compressor set up. Bed did not start; gun recoiled 2 feet 3 inches, and required to be forced down after slacking compressor.
3	P. B.	- - Bed lanyards let go; compressor slack. Bed did not start; gun recoiled without violence, and replaced itself.
4	Extreme depression.	- - Bed lanyards let go and compressor slack. Bed jumped out of the grooves, and gun came down to extreme elevation, carrying away handle of breech-lever. The gun recoiled to top of incline and replaced itself.
5	Ditto	- - Bed lanyards made fast and compressor slack. The bed did not start, but the rear part of it was broken by the concussion of the projecting on underneath part of cascable. The gun recoiled and replaced itself.
6	Ditto	- - Bed lanyards made fast and compressor taut. Bed did not start; gun recoiled to top of incline, and required to be forced down. The shoulder against which the upper part of the carriage strikes, on recoiling, was observed to be cracked.
7	Ditto	- - Bed lanyards made fast, and compressor set up. Bed did not start; gun recoiled 2½ feet, and required to be forced down. Chock at bottom of incline, appeared to have started very slightly by the concussion of replacing after recoil.

THE gun-boat was then heeled over by transporting guns and shot, and filling lee boat with water, and the following rounds fired as a weather gun, the moment of firing being the extreme of the lee roll:

No.	Elevation.	Heel at Moment of Firing.	REMARKS.
8	Extreme depression.	7 degrees	- - Bed lanyards made fast, compressor set up. Bed did not start; gun recoiled to top of incline, and replaced itself after slacking compressor.
9	Ditto	6 degrees	- - Bed lanyards let go, compressor set up. Bed jumped out of grooves, and gun came down to extreme elevation; the gun recoiled to top of incline, and replaced itself after slacking compressor.
10	Ditto	7 degrees	- - The gun was fired under the same circumstances, and with the same result, as the previous round.
11	Ditto	10 degrees	- - Bed lanyards fast, and compressor set up. Bed did not start; gun recoiled to top of incline, and replaced itself after slacking compressor.
12	Extreme elevation.	9 degrees	- - Bed lanyards fast, compressor set up. Bed did not start; gun recoiled 1 foot 9 inches, and replaced itself after slacking compressor.
13	Ditto	7 degrees	- - Bed lanyards let go, compressor set up. Bed did not start; gun recoiled 1 foot 9 inches, and replaced itself after slacking compressor.

— No. 4. — App. No. 28.

Her Majesty's Ship "Excellent," 29 August 1860.

RECEIVED on board, for Experiment, 200 wads for the 40-Pounder Armstrong Gun, 180 of which were composed of two parts of Lubricant and one of Sawdust, and 20 of three parts of Lubricant and one of Sawdust.

18 September 1860.

THE following experiment took place in order to ascertain whether, by the use of these wads, the sponging after every round could be dispensed with, the deposit left in the gun after firing being kept in so soft a state as not to fill up the grooves and render the projectile liable to strip:—

Eleven rounds were fired, the gun being loaded with solid shot and 5lb. charges, a wad (composed of two parts lubricant and one part sawdust) being placed between the projectile and the cartridge. Each round was fired at a target distant 2,600 yards; the interval between the rounds was no longer than was required to examine the bore, load and lay the gun (never exceeding five minutes). The gun was not sponged out or otherwise cleaned.

Before commencing the experiment, the grooves were perfectly clean and slightly greased, and the bore was carefully examined after each round.

Result.—The deposit in the grooves was found to form a thin scale, soft and easily removed. This scale did not appear to thicken or become harder, but was as soft and thin after the eleventh round as after the first, the bore being apparently well lubricated after every round. When the firing was discontinued, the grooves appeared as sharp and as clearly defined as they were before the experiment commenced.

The gun was then left without being sponged, the vent-piece being in the slot, screwed up into its place, and the muzzle closed with a piece of tarpaulin.

19 September 1860.

Trial with the same description of Wads continued.

On examination the bore of the gun was found in precisely the same condition as it was left on the preceding evening: no appearance whatever of rust.

Four rounds were then fired under similar circumstances to those of yesterday, the bore being carefully examined after each round.

Result.—For the first three rounds, the deposit in the grooves appeared in the same condition as during the experiment of yesterday, neither thickening nor becoming harder.

After the fourth round, the bore did not appear so well lubricated as heretofore, the deposit being apparently a little hard, but of no thickness.

The gun was then left as on the preceding evening.

20 September 1860.

Experiment with the same description of Wads continued.

When the bore was examined before commencing the experiment, it appeared in precisely the same condition as it was left on the preceding evening.

Four rounds were then fired under similar circumstances to those of the former experiments, the bore being examined after each round.

Result.—The bore appeared well lubricated, the scale on the grooves not thickening or becoming harder. The chamber was observed to be exceedingly foul, the deposit forming a hard scale of considerable thickness. It having been observed that the free action of the atmosphere had a tendency to dissolve the deposit on the grooves and chamber, the vent-piece was taken out, and the gun left, without being sponged, with a thorough current of air through the bore.

21 September 1860.

Experiment with the same description of Wads continued.

When the bore was examined before commencing the experiment, the chamber and grooves were found to be perfectly free from scale or other foulness; there was considerable moisture in the bore, but no appearance of rust whatever.

Four rounds were then fired under similar circumstances to those of the former experiment.

Result.—The bore appeared well lubricated, and in rather a better condition than after the experiment of the preceding days, the scale on the grooves being exceedingly thin and soft.

The chamber had, however, fouled to a considerable extent.

The gun was then left as on the preceding evening.

22 September 1860.

On examination, the grooves and chamber were found to be entirely free from scale; there was a considerable degree of moisture in the gun, but no appearance of rust. The gun was left as before, without being sponged.

23 September 1860.

The moisture was found to have nearly disappeared, and a thin soft deposit of an oily nature left on the grooves and chamber; no appearance of rust. The gun was left as before.

24 September 1860.

The bore of the gun was found to be a good deal drier, but no appearance of rust or of the deposit hardening.

The bore was then completely cleaned, without any difficulty, by means of a dry sponge, the grooves, &c. appearing in precisely the same condition as before the experiment commenced.

Note.—During the experiment the weather was exceedingly wet, and for the last five days the bore was freely exposed to the damp sea air.

26 September 1860.

Experiment with the same description of Wads continued.

Before commencing the bore was perfectly clean and slightly greased.

Twelve rounds were fired under precisely similar circumstances to those of the former experiments.

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When the firing was discontinued the bore appeared well lubricated, the usual thin scale on the grooves, and the chamber considerably fouled.

The gun was then left, without being sponged, with a free current of air through the bore.

27 September 1860.

On examination the scale and foulness were found to have in a great measure dissolved, leaving considerable moisture in the gun.

28 September 1860.

The scale on the grooves was found to have entirely disappeared, leaving a soft thin deposit all through the bore; a little foulness still in the end of the chamber.

29 September 1860.

No appearance of moisture in the bore, nor of the deposit hardening; no sign of rust. The gun was cleaned, without any difficulty, by means of a dry sponge, the grooves, &c. appearing in as perfect order as before the experiment commenced.

— No. 5 —

Her Majesty's Ship "Excellent," 26 October 1860.

Gun, Armstrong, 12-pounder; Charge, 1½ lb.; Projectile-shot, 12 lbs.; Weight of Gun, 8 cwt.

EXPERIMENT with Boat's Carriage, in which the recoil is received upon Indiarubber Buffers, being a modification of the plan experimented upon in July last.

WITH a view of reducing the violence of recoil, the length of the bar running along the centre of the slide was increased, so as to contain 11 Indiarubber buffers behind the traveller and four in front.

The bar was also secured in its place by the drop-bolt for the slide to pivot upon, reeving through an eye in the end of it, instead of the transverse bolt used in the former experiment.

Five rounds were then fired, the gun recoiling 12 inches each round, and replacing itself with considerable violence, the five additional Indiarubber rings thus giving only an increase of two inches in recoil.

Five buffers were then removed from behind the traveller, leaving a space of 11 inches for the carriage to recoil before the traveller reached the six remaining buffers.

The gun was then fired as follows; compressors set up as taut as possible:—

No. 1.—Recoiled 21⅛ inches and ran out 16½ inches. One of the Indiarubber buffers was then replaced, leaving a space of 8½ inches for the carriage to recoil before reaching the buffers.

No. 2.—Recoiled 19½ inches and ran out 12½ inches; removed one buffer from before and one from behind the traveller, leaving a space of 13½ inches for the carriage to recoil before reaching the buffer.

No. 3.—Recoiled 22½ inches and ran out 11 inches.

No. 4.—Fired without running out, when it recoiled 11 inches and ran out 7½ inches.

No. 5.—Without setting up compressor: recoiled 23½ inches, and replaced itself.

The rear part of the slide was then chocked up, so as to give it an inclination of five degrees.

No. 6. Without using compressor: recoiled 22 inches and ran out 18 inches.

No. 7. Compressor set up: recoiled 18 inches and ran out 8 inches.

It appears, therefore, that by leaving a space in rear of the traveller for the carriage to recoil before being checked by the buffers, the elasticity of the remaining buffers on the bar is not sufficient to cause the carriage to replace itself. The Indiarubber buffers were therefore replaced, and the trial continued with 11 buffers behind the traveller and four in front of it.

As it was considered that the timbers of the launch from which the foregoing rounds were fired were much stronger than those in the generality of boats in which this gun will be mounted, the following rounds were fired from the bows of a 32-foot pinnacé; the drop-bolt for securing the slide, and to which the bar containing the Indiarubber buffers was secured, being bolted through the head sheets three inches in thickness:—

Twenty-eight rounds were fired without using any compressor; the gun recoiled 11⅛ inches each round, and replaced itself with considerable force.

Though the recoil appeared violent, and the effect of recoil upon the boat was such as to prevent the possibility of standing upon the thwarts without being thrown forward by it, no injury whatever was done to carriage, fighting-bolt, or bar for containing buffers.

Two rounds were afterwards fired with the bar for containing buffers disconnected and a breeching rove.

In the first round the compressor was set up, and gun recoiled easily 34 inches without tautening the breeching.

In the second round the compressor was slack, and the gun recoiled to a taut breech (38 inches) without violence.

The bar containing Indiarubber buffers was then reconnected and the firing continued.

After the sixth round, making altogether 34 rounds fired from this boat, and using the non-recoil apparatus, the bolts for securing the fighting-thwart to the breast-hook drew, and the fighting-thwart was turned completely over by the recoil of the slide, which came back bodily about 18 inches from its former position.

From the appearance of the holes in the breast-hook, through which the fighting-thwart was bolted, it was quite evident that no forelocks had been drawn through; and on examining the bolts in the fighting-thwart, the forelocks appeared to have been completely eaten away by rust.

The fighting-thwart was then re-secured to the breast-hook by 4⅜-inch bolts, properly forelocked, and 50 rounds fired from the gun, as in former trial. No compressor was used.

The gun recoiled each round with considerable violence; the compression of the indiarubber rings behind the traveller allowed a recoil of 11½ inches,

inches, the rebound causing the gun to run out 13½ inches—the rings in front of the traveller thus yielding 2 inches to the force with which the gun is run out by the rings in rear.

Two rounds were then fired with compressor set up, when the gun recoiled and replaced itself as before, except that the rebound after recoil was so far diminished as to render the compression of the rings in front of the traveller imperceptible. The jar of recoil caused the rear part of the slide to jump some inches from the thwart every time the gun was fired.

On the completion of the 52d round the fighting-thwart was found to have started back ¾ inch, the bolts for securing it to the breast-hook being slightly bent. No portion of the recoil apparatus or carriage appeared to have sustained any injury; and though the fighting-thwart had started, it was still in a perfectly serviceable condition.

It appears, further, that the manner of securing fighting-thwarts is defective, owing to the whole strain of recoil being exerted in a direction at right angles to the length of the bolts which hold it.

Probably if the breast-hook were made deeper, so that the fighting-thwart could be bolted through it in a diagonal direction, and if the after edge of the fighting-thwart were sunk below the rising-piece, the additional security necessary to withstand the increased strain occasioned by the adoption of this plan of non-recoil would be obtained.

The chief advantage of this plan consists in its simplicity, being easily repaired, in the event of injury, by the means always at hand on board ship, easily applied to the boats' carriages now in use; and in case of damage during an action, it can be disconnected, and the carriage worked in the ordinary manner. The only objection to it appears to be the difficulty of sufficiently reducing the violence of recoil. To meet this, all that is necessary is to increase the security of the fighting-thwart, which must be done whatever plan of non-recoil is adopted. As in the present fittings, the fighting-thwart is only intended for the gun to pivot upon, and to secure it from shifting its position with the motion of the boat, the whole strain of recoil being received by the breeching; whereas in any non-recoil apparatus this strain must be received by the fighting-bolt, the breeching (if one be used at all) being merely a preventer.

— No. 6. —

Her Majesty's Ship "Excellent," November 1860.

TRIAL of Naval Carriage, for the Armstrong 40-pounder.

THE carriage was constructed in a similar manner to the ordinary rear chock carriage, with holes cut in the brackets for the breeching to reeve through.

The elevation was obtained by combining the use of bed-stool and depression chock with that of the elevating screw in the following manner:—

The stool was hung by hinges underneath the bed, and worked by a lanyard, by which it could be raised so as to form a chock between the bed and rear axletree, or be lowered so as to hang in front of the rear axletree while the bed rested upon it.

Through the centre of the bed worked a short elevating screw, equal, when at full height, to the depth of either the depression chock or swinging stool. The screw, which worked through a hole in the rear axletree and through a groove in the bed-stool, was capped with a broad metal top for the base of the gun to rest upon.

The depression chock was fitted in the ordinary manner.

The following elevations were obtained by this plan:—

Extreme elevation, bed removed, and gun resting on rear chock	23 degrees.
Bed in its place, with screw close down	15 degrees.
Ditto, with screw at its full height, or bed resting on stool, and screw close down	7½ degrees.
Bed resting on stool with screw at its full height, or with bed resting on stool and pivot depression chock, with screw close down	P. B.
Ditto, with screw at its full height	7½° depression,

—the intermediate degrees from 15° elevation to 0.39.

7½° depresssion being given by screw, and those from 15° to 23° of elevation by coin.

Five rounds were fired with 7½° elevation, the bed resting on its stool, with the screw close down.

Then 15 rounds with the same elevation, the bed resting on the rear chock, and screw raised to its full height.

Then five rounds at P. B., the bed resting on its stool, and screw at its full height.

The gun recoiled without violence, scarcely tautening the breeching, which was secured so as to allow a recoil of about five feet.

The elevating screw appeared to answer satisfactorily, the concussion of firing causing little or no jar at the point where the breech rests upon the head of the screw.

This was the chief point to be tested by firing, the other peculiarities of the carriage relating to the actual amount of elevation and depression the gun was capable of receiving in it; and the convenience and suitableness of the means employed for that purpose did not require that the gun should be fired to try them. The screw was not in any way affected by the firing, though during the last 20 rounds the gun was fired with the screw at its full height, in which position the concussion of firing would have the greatest tendency to strain it.

So far, therefore, as regards the practicability of permitting the gun to rest upon the elevating screw without being connected by bolting the screw to the cascable, the experiment is quite conclusive.

It will be necessary, however, to devise some means for preventing the screw from being used without a complete thread being entered in the female screw of the bed; otherwise it would be very liable to become strained by firing.

Some inconvenience was found owing to the arms of the elevating screw fouling the breech-

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lever, but as it will always be necessary when raising the elevating screw to take the weight of the gun off it with a handspike; these arms may be made as short as requisite. In every respect the screw is a great improvement on the coin, which owing to the slimy nature of the deposit with which it is covered after firing a very few rounds is very difficult to keep in its place, and which is further rendered inapplicable to guns loaded on Sir William Armstrong's principle, owing to the difficulty of preventing it from interfering with the working of the breech lever.

The swinging stool and depression chock were easily worked, and there is no doubt that with practice the crew could be taught to shift from one elevation to another, with as little difficulty as in the present arrangement for smooth bored guns.

The gun, however, appeared to work more heavily than would have been expected from its weight. A crew of 13 men not being found more than sufficient to run out, without attempting to load at the same time, and this is allowing five more men than are allowed by the establishment for smooth bored guns of the same weight.

The rear chock carriage appears to be inappropriate for this description of gun for the following reasons,—

1st. That the use of the roller handspike for running out interferes with the operation of loading.

2d. That the increased difficulty in running out with carriages constructed on this plan, renders the number of men necessary for the efficient working of the gun quite out of proportion to its weight.

It therefore, appears desirable, that rear trucks should be substituted for the rear chock, which will enable the gun to be run out and loaded simultaneously when firing in smooth water, and in the event of firing in a heavy sea way, when it is necessary to increase the stability of the carriage, the rear trucks can always be removed, in which case the gun should be loaded after running out.

During the above experiment an accident occurred, owing to the breech not being properly closed. On firing the 16th round a violent explosion took place, instantly enveloping everything within several yards of the gun in a dense cloud of smoke, which prevented the extent and precise nature of the accident from being ascertained for some seconds after its occurrence. On examination it was found that the top of the vent piece to which the handles are fixed, had been blown off, and thrown with great force against the beams overhead. The deck and carlines immediately above the explosion were started considerably. All the bulkheads fore and aft the deck were more or less injured, and a considerable quantity of glass smashed.

No injury was done to the crew working the gun. It appears that the deposit formed by the previous firing on the worm of the breech screw, had caused it to work so stiffly that the captain of the gun, having turned the lever till it would go no further, supposed the vent piece had been home, and gave the two smart blows on the cams, which must have failed to force it into its seating.

That it must, however, have been nearly in its place is proved by the top to which the handles are attached being blown off; whereas, had the vent piece been free, it would undoubtedly have been blown out entire. The difficulty of working the breech screw after continued firing when not using water for sponging has been observed on several previous occasions, and it certainly appears advisable that some means should be adopted for preventing the recurrence of such accidents, by means of a mark made so conspicuous that the captain of the gun would never fail to see if the breech was not properly closed. The present means of ascertaining that it is closed, by feeling that the vent piece "butts" in its seating, is all that is required so long as the screw works easily; but fails when the worm of the screw is clogged with deposit after frequent firing.

— No. 7. —

Her Majesty's Ship "Excellent," 29 November 1860.

Trial of the Armstrong 40-pounder Carriage continued.

The experiment was continued on the 29th instant. The alterations found necessary on the previous trial having been carried out, namely, a rear axletree with trucks substituted for the rear chock used on the former occasion; a stop fixed at the lower part of the elevating screw, to prevent its being used at too great a height, and the arms of the elevating screw reduced so as to clear the breech lever when turned; also some alterations were made in the thickness of bed and stool to suit the increased height of rear axletree, owing to the addition of rear trucks, and to enable the screw to give somewhat more than the bare intermediate degrees of elevation between one chock and another.

The following elevations were obtained with the carriage as at present fitted:—

Extreme (bed removed, and gun resting on rear axletree)	21 degrees.
Bed in its place, with screw close down	13 degrees.
Bed in its place, with screw raised three-quarters of its height, or with bed resting on stool, and screw close down	8 degrees.
Bed resting on stool, with screw raised three-quarters of its height; or with bed resting on stool, and pivot depression chock with screw close down	1 degree.
Ditto, with screw at full height	8° depression.

The intermediate degrees, from 13 degrees elevation to 8 degrees depression, being given by the elevating screw, and those from 13 degrees to 21 degrees elevation by coin.

Five rounds were fired with the gun resting on bed and stool, and screw at its full height, the gun having about one degree depression.

Then five rounds, with gun resting on bed only, with screw at full height, the gun having about four degrees elevation, and then five rounds, as at first, with about one degree depression.

The

The gun was worked with a crew of 12 men, the loading and running out being carried on simultaneously; the time taken for firing five rounds, without altering the elevation after each round, varied from four minutes to four and a half minutes. The gun recoiled steadily to a taut breeching each round, without running out again to any perceptible extent, the breeching being secured, so as to allow a recoil of 5 feet.

During the foregoing trial, six men only were available for manning the side tackles in running out, the remainder of the crew being employed in loading. It follows, therefore, that if the operations of loading and running out were performed separately, the gun could easily be worked with a crew of seven men; and although, when the requisite number of men are available, it will be advisable to perform them simultaneously, still, considering that the extent of recoil need not be more than three feet, it appears that the time lost by running out previous to loading, when necessary to do so, will be inconsiderable.

After the above 15 rounds, one round was fired with the breeching eased up to its full length, in order to ascertain the full extent of recoil. The gun recoiled steadily to a distance of six feet one inch, without tautening the breeching.

The breeching was then taken up, so as to allow a recoil of two and three quarters feet, and two rounds fired, when the gun recoiled to a taut breeching, running out again about one or two inches.

A 32-pounder, 56 cwt., was then fired with a single shot, in order to ascertain the comparative violence of recoil:—

1st. With a distant charge and breeching, secured so as to allow a recoil of about five feet; and, 2d, with reduced charge, and breeching secured, to allow a recoil of two and a half feet. In the first instance, the gun recoiled taut breech, and ran out again one foot, and in the latter it ran out about six inches after recoil.

The comparison showed, even when taking into account some additional friction in the carriage for the Armstrong gun, owing to the axletrees having been fresh painted, that the recoil of the 32-pounder was, in both instances, at least quite as violent as that of the Armstrong gun.

The carriage, as at present fitted, answers the following requirements satisfactorily:—

1. Thirteen degrees of elevation, and eight degrees depression (in both cases more than the port admits of), are obtained without using a coin.

2. With the assistance of one handspike, for taking the weight of the gun, the screw can be run up and down with much facility, and even without the use of a handspike all small alterations of elevation can be given by one man.

3. The screw, when used continually at its full height, does not appear to be in any way affected by the jar of firing.

4. The recoil is very moderate, so that under ordinary circumstances of heel or motion at sea, the carriage, with rear trucks shipped, is quite sufficiently steady, and the ease with which it is worked, in comparison with the rear chock carriage, gives it a great advantage over it.

5. The gun so mounted can be worked with at least as much ease and quickness as is the case with an ordinary smooth-bored gun of the same weight.

— No. 8. —

Her Majesty's Ship "Excellent," 10 December 1860.

Trial of Naval Slide Carriage for the Armstrong 40-pounder.

The carriage was constructed in a similar manner to the ordinary slide carriages for pivot guns, the elevation being given by combining the use of bed and stool with that of the elevating screw in the same manner, as that previously experimented upon in a broadside carriage for the 40-pounder. As in the broadside carriage a small coin was required to be used for elevations exceeding 13 degrees.

The following elevations were obtained by this means:—

Extreme (gun resting on rear-chock) - - - - -	21 degrees.
The gun resting on coin, and coin resting on rear-chock, or gun resting in bed with screw close down - - - - -	13 degrees.
Gun resting on bed and stool with screw close down, or with screw raised ¾ its weight on bed only	8 degrees.
Gun resting on bed, stool, and depression chock with screw close down, or with screw raised ¾ its height on bed and stool only - - - -	1 degree.
Gun resting on bed, stool, and depression chock with screw raised to its full height - -	9° depression.

Four rounds were fired as follows, the gun being laid parallel to the slide, so as to give the greatest recoil it is capable of, without heeling the ship:—

1st.—With compressors set up. The gun recoiled 2 feet 8 inches without tautening the breeching.

2d.—Compressors resting on compressor stops without being set up. The gun recoiled, taut breech, 7 feet 3 inches.

The breeching was then shortened up 1 foot.

3d.—Compressors not used at all. The gun recoiled taut breech, and ran out again 6 inches.

4th.—Compressors raised upon compressor stops, but not set up. The gun recoiled taut breech.

As regards the facility of working the gun, and the ease with which the various degrees of elevation were given, the remarks made on the trial of the broadside gun carriage on 29th November last, apply equally to this description of carriage. The recoil was also very moderate, being under 3 feet when compressors were set up, and not bringing any undue strain upon the breeching, when no compressor was used.

App. No. 28.

— No. 9. —

Her Majesty's Ship "Excellent," 17 December 1860.

TRIAL of 100-pounder Armstrong Gun—Weight, 81 cwt.; length, 10 feet; calibre, 7 inches; Projectile, Solid Cast-iron Shot.

THE carriage upon which the gun was mounted, was similar to the common slide carriage fitted for both outside and inside compressors, and having holes cut in the brackets for the breeching to reeve through.

The following is an account of the firing that took place from the "Stork" gun-boat, off the east-end of the Isle of Wight.

The cartridges supplied for the trial were made too long for the chamber, and were therefore during the first seven rounds reduced sufficiently to admit of their being entered. In the last two rounds the full charge was used, shorter cartridges of larger calibre having been made for the purpose.

It was found that the lever of the inside compressor fouled the rear-chock in setting up, the outside compressors, therefore, were alone used.

No.	Charge.	Elevation.	REMARKS.
	Lbs.	*Degrees.*	
1	8½	2	Compressors set up as taut as possible. The gun recoiled about 2 feet, without tautening the breeching—No escape of gas.
2	–	–	Compressors were raised upon compressor stops, but not screwed taut up. The gun recoiled about 5 feet without bringing any strain upon the breeching—No escape of gas.
3	–	10	Compressors slack, the gun recoiled taut breech without violence—Very slight escape of gas at breech.
4	–	–	The same as previous round.
5	9½	2	Compressors set hand taut. The gun recoiled steadily about 5 feet without bringing any strain on breeching. These three rounds were fired as quickly as possible, the operation of loading being performed while the gun was being run out.
6			
7			
8	11½	2	Compressors set up, gun recoiled steadily without bringing any strain on breeching—No escape of gas.
9	–	10	The same as previous round.

Throughout the above firing no difficulty of importance was occasioned in working the gun. The shot weighing 102 lbs. were brought up in an iron bocket, with handle on each side, and a sliding bottom by which it was entered into the breech, and then rammed home by two numbers.

This bearer was not so convenient or easy to handle as that used on board the "Wrangler" in October 1859, which latter is recommended for trial. The vent-piece weighing 120 lbs., was worked easily by two men, who raised it by means of a wooden bar 4 feet in length, passing through the rings. The metal frame and stud for securing it on the top of the gun while it is being cleaned and primed was found convenient, and in this position the numbers attending it were sufficiently out of the way of those employed in loading.

The breech screw was worked easily by one man.

The arrangements for elevating, however, were found to be very imperfect, it being quite impossible to keep the coin from being thrown out by the firing. It is recommended that an elevating screw working on the bed according to the plan previously tried, and found to answer perfectly for the 40-pounder, be substituted for the use of the coin.

On the completion of the above rounds, a flaw of about 2½ inches in length, and ¼ inch in depth was observed in the grooving about 10 inches from the muzzle.

EXPERIMENT with the Armstrong 100-pounder, continued from "Stork," 18 December 1861.

No.	Charge.	Elevation.	REMARKS.
	Lbs.		
1	11½	P.B. - -	Compressors set up hand taut, gun recoiled steadily to a taut breech—No escape of gas.
2	–	–	As in previous round.
3	–	Extreme Depression.	Compressors set up hand taut, gun recoiled steadily without tautening the breeching—No escape of gas.

The flaw in the grooves was observed to have increased considerably, measuring at the completion of the firing 4 inches in length, by ¼ inch in depth, and as it was doubtful how far this flaw was repairable, it was thought advisable to discontinue the firing for the present.

Throughout the above rounds a tin cup was used in rear of the chamber, with a hole in the centre, to allow of the fire from the tube communicating with the charge. The object of the tin cup was to prevent all escape of gas which it appeared to do effectually when the face of the vent-piece was perfectly clean, although, when any deposit from previous firing was left upon it, thus preventing it from bearing perfectly evenly against the surface of the tin cup, a very slight escape was observed.

The plan adopted for ascertaining the escape of gas, was by ramming a quantity of paper all round the seating of the vent-piece, after the latter had been set home, so that the smallest escape of gas was certain to be detected, by its leaving its mark upon the paper.

— No. 10. —

Her Majesty's Ship "Excellent," 3 January 1861.

TRIAL of the 25-pounder ARMSTRONG GUN, when used as a Boat's Gun; weight of Gun, 12 cwt.

THE gun was mounted in a 42-foot pinnace launch, in which the fighting thwart had been strengthened, in order to enable it to withstand the additional strain brought upon it when firing the gun on a non-recoil carriage.

1st. The gun was mounted on a common boat's carriage, the breeching being secured so as to allow a recoil of three feet.

Ten rounds were fired, using 2½ lbs. charges, 25 lbs. shot, the gun being laid with 3° elevation. Compressor set up as taut as possible each round.

Remarks.—Towards the conclusion of the firing, the breeching having given out, the recoil had increased to 3½ feet. The recoil was, however, by no means violent, and no undue strain was brought on breeching, bolts, &c.

The gun was run out with ease after each round by six men, the side tackles being hooked on to strops in the gunwale of the boat, so as to bring the lead more in line with the slide.

— No. 11. —

4 January 1861.

TRIAL with the 25-pounder ARMSTRONG GUN, continued from the same 42-foot launch, at Spithead.

THE gun was mounted on a non-recoil buffer carriage, there being no space between the traveller and rear buffer.

Charge, 2½ lbs. projectile, 25 lbs. shot.

1st. Five rounds were fired, with compressor slack, and 3½° elevation.

The gun recoiled from 8 to 10 inches on the slide, and replaced itself with great violence.

2d. Two rounds were fired, with compressor taut, and with the same elevation.

The gun recoiled 10 inches, and ran out 7 inches.

3d. Two rounds, compressor taut, and gun laid horizontal.

The gun recoiled 10 inches, and replaced itself.

4th. Eleven rounds, compressors taut, and 3½° elevation.

The gun recoiled 10 inches, and replaced itself.

5th. Four rounds, with buffers removed.

No. 1. Compressor set up, the gun recoiled 2 feet 9 inches; did not tauten the breeching.

No. 2. Compressor slack, the gun recoiled taut breech 3 feet 10 inches, bringing, however, no violent strain on breeching or bolts.

Nos. 3 and 4. Compressor slack, and breeching shortened up to 3 feet 2 inches; the gun recoiled to taut breech, bringing, however, no undue strain on breeching or bolts.

Remarks on the above Trial.

Before removing the buffers, the carriage, &c. was examined, and the fore chock of the slide was found started considerably, through the bolts connecting it to the slide not being clinched; the fighting bolt was also found much bent.

— No. 12. —

The gun was now mounted on the inclined plane non-recoil carriage.

The following rounds were fired, using 2½ lbs. charge, projectile, 25 lbs. shot.

The gun being depressed, so as to bring the recoil as nearly in a line with the incline plane as possible.

Four rounds, with compressor taut.

The gun came back with considerable violence. Great difficulty was experienced in starting the compressor and getting the gun down the plane.

Another round was then fired under similar circumstances: on the gun recoiling the fighting bolt connecting the carriage and slide carried away, and the gun and carriage fell over on the starboard bow.

App. No. 28.

— No. 13. —

Her Majesty's Ship "Excellent," 29 January 1861.

The following rounds were fired on board the steam tender "Stork" at Spithead, from a Whitworth 80-pounder breech-loading gun (received on board for experiment), in order to test its suitableness both as a breech and muzzle-loading naval gun.

Weight of gun, 81 cwt.
Diameter of bore from angle to angle, 5·6″.
„ „ „ face to face, 5·05″.
Twist of rifling, 1 in 20 calibres.
Length of rifling, 9′ 9″.
Charge - 12 lbs.

Projectile.—Solid cast-iron shot, weight 71 lbs.
Length, 16 in.; greatest diameter, 5·48″.
Diameter, base, 2·65″: point, conical.

1st. Two rounds were fired, the gun being loaded at the breech, using Mr. Whitworth's tin cartridge-case and lubricating wad; the breeching was secured, so as to allow a recoil of 5 feet; gun laid horizontal, both inside and outside; compressors set up; vessel rolling from 2° to 3° each way.

Remarks.—The loading was perfectly easy, two men being sufficient to attend the breech. The projectile struck the water at about 800 yards from the gun, ricochetted about three times, at an angle (with line of fire) to the right of about 20°, striking the water the second time at about 1,600 yards from the gun; the projectile dropped at about 3,000 yards; recoil very easy, 3′ 6″. The bore did not appear well lubricated, there being a hard, dry, thin deposit remaining. At the second round the cartridge case was so damaged as to render it unfit to be used again; owing to the slight motion of the vessel, the projectile frequently started from the cartridge, occasionally as much as 7 or 8 inches; this occurred all through the practice, so that it was necessary, before firing each round, to ascertain that the projectile was home with the rammer, which was marked.

2nd. Three rounds were then fired, the gun being loaded at the breech, using a tight fitting flannel cartridge, and the Whitworth short tin case, and lubricating wad. The gun was laid as before, the outside compressors being the only ones used.

Remarks.—Recoil very moderate, 3′ 8″; range much the same as with the first two rounds, the same particulars being noticed, namely, the projectile, after the first graze, invariably turning off to the right, at an increasing angle of between 20° and 30°, the first ricochet being of very great and uncertain extent.

The bore did not appear well lubricated, and had the same appearance as after the first two rounds. The bottom of the bore, or seat of the cartridge, became excessively foul, a thick hard deposit being left after each round, extending from the rear about 16 inches up the bore, also numerous globules of solder from the tin case was observed. This deposit increased so rapidly, that after the second round the gun could not be loaded until it had been sponged thoroughly out with a wet sponge.

3d. Two rounds were then fired, entering the cartridge, wad, and projectile at the muzzle; a tight-fitting flannel cartridge was used, and a short tin case had to be introduced, each round in the rear, before screwing up the breech; the gun was laid as before, and the outside compressors set up.

Remarks.—Some grit or dirt having got in between the threads of the breech screw, supposed to have dropped from the funnel (this was not observed till after attempting to screw the breech), for some time it was found impossible to secure the breech; after a delay of three quarters of an hour, and considerable trouble, this was, however, effected. The recoil, as before, was very easy.

A very considerable difficulty was experienced in getting the cartridge home, for as it was made to fit the bore, it would not readily enter the short tin case also, although the cartridge fitted easily when the bore was clean; the dry deposit reduced the diameter of the bore, and made the cartridge fit very taut. A wad composed of the same material as that used with the Armstrong guns was entered between the cartridge and projectile, for the first of these rounds; the bore, however, did not appear better lubricated, the same dry deposit remaining. Mr. Whitworth's wads were therefore used for the remainder of the practice; a dry sponge was used after every round.

4th. The cartridge was then reduced ¼ of an inch in diameter, and the gun loaded at the muzzle as before. Compressors slack. One round was then fired, the gun being laid as before.

Remarks.—Very little difficulty was experienced in getting the cartridge home. The projectile, however, did not load readily, but hung for a considerable time about a foot from its seat; recoil, 4′ 6″; range, as before. The appearance of the bore was the same as after the previous rounds.

5th. Six rounds were then fired, the gun being loaded at the breech, using Mr. Whitworth's long cartridge case and wad.

Remarks.—The time occupied in firing these rounds was about 12½ minutes; most of the cartridge cases employed had been previously used, and being more or less damaged, a little difficulty was occasionally experienced in entering them, the loading was consequently not quite so rapid as it would have been had new cases been used. The breech was easily worked by two men. In loading

loading for the 5th round, some difficulty was experienced in entering the projectile through the fouling of the bottom of the bore.

After the 6th round, the breech screw was observed to have started back about half an inch; this is supposed to have been caused by the projectile having started from the cartridge before firing, and consequently an undue strain brought upon the breech.

6th. Two rounds were then fired, the gun being loaded at the breech, using Mr. Whitworth's long cartridge and wad.

The gun was laid with 11° elevation, the vessel rolling about 3° each way, outside compressor set up.

Remarks.—No difficulty in entering projectile or cartridge. It however required four men to work the breech, for from the high elevation of the gun, and the great weight of the breech, two men could not retain it in its place when closed, and at the same time work the screw. The recoil very easy, 3′ 1″. The range appeared very great, but there was no means of estimating it with accuracy.

7th. The flannel cartridge having been reduced half an inch in diameter, two rounds were fired, the cartridge, wad, and projectile being entered at the muzzle, and a short tin case introduced into the bottom of the bore before the breech was secured for each round. The gun was laid horizontal, and the outside compressor set up.

Remarks.—No difficulty in loading for the 1st round; for the 2d, the projectile hung a little, about one foot from the cartridge; it was, however, easily knocked home; recoil very easy, about 3′ 5″. The bore presented much the same appearance as after the former rounds, the deposit remaining hard, but apparently not increasing in thickness; the seat of the cartridge, however, became exceedingly foul. The gun was then thoroughly cleaned with a wet sponge without any difficulty.

Note.—The vent is contained in a steel screw plug; it is lined with platinum, and conical in form; the exterior opening being about ·2 of an inch, the interior excessively minute. Before the experiment commenced the vent was observed to be foul; an attempt was made to clear it by firing off three or four tubes; this, however, failed. A needle was then introduced in the rear in order to remove the obstruction; in spite of the utmost care, about a quarter of an inch of the needle broke off in the vent, and effectually spiked the gun. In order to clear this, the vent had to be unscrewed and the needle punched out, which operation occupied at least 1½ hours.

30 January 1861.

The following experiment took place in order to test the penetrating power of the Whitworth 80-pounder. The rounds were fired from the steam tender "Stork," moored at 200 yards from the frigate "Sirius," to the side of which was attached the iron plate which formed the target.

The target was a portion of a 4½ scrap wrought iron plate, being of the same material as that intended for the armour of the "Warrior;" the original plate measured 16′ 4″ × 6′, some portion of which had been broken or otherwise damaged during previous experiments.

The target, however, was perfectly sound and well supported in the rear by main deck shelf piece, knee and beam. It measured 5′ 3″ × 3′ 1″, and was composed of three-quarter scrap, and one-quarter puddled iron.

1st. Round.—The gun was loaded, was a cast-iron solid projectile, weight 70 lbs., charge 12 lbs., and laid for some point in the side of the frigate clear of the target, elevation 12° (intended merely as a trial shot).

Result.—Struck a little above the spot aimed at, penetrated the ship's side just above the main deck waterways, making a clear round hole of about 3 inches in diameter, with very few splinters; then ripped up the planking of the main deck for about 12 feet in length and 4 inches in depth; struck and carried away a train tackle bolt; the projectile then broke in two pieces, which glanced upwards and penetrated the ship's side just below upper deck beam, making a large jagged hole and numerous splinters; the pieces of the projectile then fell into the water at 500 yards from the frigate.

2nd Projectile.—Flat headed steel bolt, weight, 70 lbs.; length, 12·65″; diameter, greatest, 5·49″; rear, 4·22″; front, 4·74″; charge, 12 lbs.

The gun was laid for centre of target.

Result.—Struck and penetrated the ship's side, just above the target, making a clear round hole, passed across the deck, and struck a heap of iron ballast on the opposite side, broke in pieces three pigs, passed out of maindeck port, grazing the lower portsill, then fell in the water, 300 yards from frigate.

3rd Round.—Projectile and charge as in the preceding round. The gun was laid for the centre of the target.

Result.—Struck the target direct about nine inches from the upper, 12 inches from after edge. The projectile fell back into the water, about 10 yards from frigate.

Indentation	diameter	5·8 inches
„	depth	2·8 „

A crack of about eight inches in length extended round a portion of the indentation at two inches from its edge. Damage inboard: Inner planking close before the knee, slightly shaken, no bolts started.

31 January 1861.

On the gun being thoroughly cleaned and examined this morning, a fracture was observed extending from the rear, about 2′ 9″ up the bore; it appeared in the rear to extend completely through the inner cylinder and first ring of hoops to the depth of 2·6″; the parts of the fracture were quite close, except for about four inches from the fore-end where they separated, forming a jagged crack of ·35 of an inch in width and 3·9″ in depth. This fracture was considered as injuring the gun to such an extent that the experiment could not be continued.

Note.—The deepest and most open portion of the fracture appeared to correspond exactly with the position of the hardened flat head of the projectile when in its place, close home against the cartridge.

App. No. 28.

— No. 14. —

Her Majesty's Ship "Excellent," 26 February 1861.

The following experiment took place in order to test the lubricating qualities of certain wads composed of three parts of lubricant and one of sawdust:—

Twenty rounds were fired from a 40-pounder Armstrong gun, at a target distant 2,600 yards; the gun was laid carefully each round, and steady independent firing carried on. Before commencing, the bore was perfectly clean and slightly greased, and during the experiment the sponge was not used, nor was the gun cleaned in any way.

Result.—Throughout the practice the bore appeared well lubricated, the deposit on the grooves being thin and easily removed; at first it appeared a little hard, but did not thicken as the practice continued.

The chamber, however, appeared exceedingly foul, a hard dry scale of about 1-16th of an inch in thickness, having formed all over it. The gun was then left without being sponged, with a free current of air through the bore.

27 February 1861.

On examination, the scale on both grooves and chamber was found to have in a great measure dissolved, leaving considerable moisture in the bore, but no appearance of rust.

28 February 1861.

On examination the bore was found considerably drier, a thin oily deposit on the grooves and chamber. No appearance of rust. The bore was now thoroughly cleaned with a dry sponge without any difficulty, the grooves, &c., appearing in as perfect order as before the experiment commenced.

— No. 15 —

Her Majesty's Ship "Excellent," 22 May 1861.

Received on board a shortened 12-pounder Armstrong gun, intended to form the armament of pinnaces, and also as a light field gun. Register, No. 353; length of rifling, 4 feet 5 inches; extreme length, 6 feet; weight, 8 cwt. 0 qrs. 24 lbs.

The gun was mounted in the bows of a foot pinnace, on a common boat's carriage fitted in the usual manner; the following rounds were fired in order to ascertain whether the gun thus mounted could be worked conveniently, whether the ordinary fittings were sufficient; also, whether the recoil was excessive or otherwise.

During the practice the gun was laid each round for a target distant 1,200 yards. Charge, 1 lb. 8 oz.; projectile, segment shell; weight, 10¾ lbs.

1st. The breeching was secured so as to allow a recoil of 2 feet 6 inches. Six rounds were fired at the above-mentioned target, compressor being hove up each round.

Remarks.—The gun recoiled, sharply tautening the breeching, but apparently bringing no undue strain upon it; after the first two rounds the breeching gave 2 inches, the recoil being for the last four rounds about 2 feet 8 inches.

The gun was worked with ease by five men.

2d. Three rounds of rapid independent firing at the same target; compressors hove up each round.

Remarks.—The gun was worked with ease and comparative rapidity, the rounds being fired with good accuracy in five minutes; recoil sharp, but by no means excessive.

3d. The breeching was secured so as to allow a recoil of 1 foot 9 inches. Three rounds were fired at the same target; compressor being hove up.

Remarks.—The gun recoiled sharply each round, but not so as to distress the breeching in the least.

4th. The breeching was secured so as to allow a recoil of three feet.

One round was fired with compressor slack.

Remarks.—Recoil sharp to a taut breech.

General Remarks.

The gun appears well adapted to form the armament of a pinnace, combining great power with comparative lightness; the recoil is also not excessive; it can be worked with ease by five men, and the ordinary fittings appear perfectly suitable.

The gun was now mounted on the ordinary 12-pounder naval field carriage, taken on shore to the exercising ground, and the various evolutions connected with the field piece and battery drill performed with the usual crew of 15 men.

Remarks.—The gun appears well adapted for a field gun; with a trained crew of 15 men it can be worked with as much ease and rapidity as the ordinary 12-pounder howitzer, the additional weight of 2 cwt. making no perceptible difference.

The drill, as laid down in the Armstrong Gun Instruction, appears perfectly suitable for this gun.

5 June 1861.

The following rounds were fired from the long 12-pounder Armstrong gun, and also the shortened 12-pounder Armstrong or service pinnace gun, with a view of ascertaining whether at long ranges the latter gun was inferior to the former, either as to range or accuracy of fire.

Both guns were mounted on the battery, and worked steadily by the same crew; the target was 14 feet square, distant from the guns 2,550 yards.

The charge of powder, projectile, and elevation used being the same from both guns, viz.:—charge, 1 lb. 8 oz.; projectile, 10¾ lbs.; elevation, 7° 5′.

Long

Long 12-pounder Armstrong, weight 8½ cwt.

No. of Rounds.	Actual Range.	Beyond or Short of Target.	Deflection.
1st -	2,580 yards	30 yards beyond -	1 yard right.
2d -	2,550 „ -	0 - - -	1 „ „
3d -	2,570 „ -	20 yards beyond -	Through the target.
4th -	2,570 „ -	20 „ „ -	Through the target.
5th -	2,550 „ -	0 - - -	1 yard left.
6th -	2,575 „ -	25 yards beyond -	1 „ right.
7th -	2,580 „ -	30 „ „ -	1 „ „
8th -	2,565 „ -	15 „ „ -	Through the target.
9th -	2,570 „ -	20 „ „ -	Direct.
10th -	2,558 „ -	8 „ „ -	1 yard right.

Armstrong's shortened 12-pounder or Pinnace Gun, weight, 8 cwt.

No. of Rounds.	Actual Range.	Beyond or Short of Target,	Deflection.
1st -	2,570 yards	20 yards beyond -	3 yards left.
2d -	2,565 „ -	15 „ „ -	3 „ „
3d -	2,570 „ -	20 „ „ -	Direct.
4th -	2,570 „ -	20 „ „ -	Through the target.
5th -	2,545 „ -	5 yards short -	1 yard right.
6th -	2,545 „ -	5 „ „ -	5 yards left.
7th -	2,550 „ -	0 - - -	Direct.
8th -	2,545 „ -	5 yards short -	„
9th -	2,550 „ -	0 - - -	Through the target.

The following 10 rounds were fired as rapidly as possible from the pinnace-gun at the same target:— App. No. 28.

No. of Rounds.	Actual Range.	Beyond or Short of Target.	Deflection.
1st -	2,545 yards	5 yards short -	1 yard left.
2d -	2,540 „ -	10 „ „ -	1 „ „
3d -	2,450 „ -	100 „ „ -	Direct.
4th -	2,560 „ -	10 yards beyond	3 yards left.
5th -	2,530 „ -	20 „ short -	1 „ „
6th -	2,560 „ -	10 „ beyond	Direct.
7th -	2,745 „ -	5 „ short -	„
8th -	2,545 „ -	5 „ „ -	1 yard left.
9th -	2,540 „ -	10 „ „ -	1 „ „
10th -	2,545 „ -	5 „ „ -	Direct.

Note.—In the last 10 rounds it will be perceived that the projectile of No. 2 round fell 10 yards short, that of No. 4, 10 yards beyond, whereas that of No. 3 fell 100 yards short; it appears evident from this and the general regularity of the ranges, that the discrepancy noticeable here must have been due to errors in the laying of the gun. During the firing a range party was stationed 200 yards from and abreast of the target.

— No. 16. —

Her Majesty's Ship "Excellent," 3 June 1861.

Received on board for trial 50 felt lubricating wads for the Armstrong 100-pounder gun. These wads were apparently composed of felt and tallow, with a backing of half-inch elm.

Dimensions of Wads:—Diameter - - - - - - - - 7·1 inches.
Thickness, exclusive of wooden backing - - 2 „

The following experiment took place, in order to test their efficiency in lubricating the bore and chamber.

The rounds were fired from a 100-pounder Armstrong gun, Register No. 70, on board Her Majesty's steam-tender "Stork," at Spithead, with the undermentioned result:

Charge, 12 lbs.; segment shell, 101 lbs.; common shell, 104 lbs.

The tin cup in the rear of the cartridge was used every round.

1st. Two rounds at a target, distant about 800 yards; the gun loaded with common shell and time fuze.

Remarks.—After firing each round, the tin cup was forced right through the bore from breech to muzzle, with the indentation of effectually cleansing both bore and chamber. This operation was attended with but little difficulty. On examination, it appeared from the marks on the edges of the cup, &c., that it had in part answered the desired end, as it had carried with it some portion of the deposit from the upper part of the lans. The chamber, however, seemed but little affected, the scale not having broken away to any great extent. The bore and chamber appeared but indifferently lubricated, there being a hard dry deposit remaining in the grooves, and the chamber was very foul with hard scales, &c.

The shell burst well close to the target; no difficulty was experienced in loading.

2d. Two rounds at a target, distant 900 yards; the gun was loaded with segment shell and time fuze.

Remarks.—After firing, the tin cup was forced through as before, and with much the same result. The bore and chamber appeared still but indifferently lubricated, the chamber being apparently little affected by either wad or cup.

The shell burst well; no difficulty was experienced in loading.

3d. One round at a target, distant 1,000 yards, the gun being loaded with common shell and time fuze.

Remarks.—The tin cup was forced through as before, with apparently the same result. The bore, however, appeared to be a little better lubricated, but the chamber was still very foul. Shell burst well a little over the target; no difficulty was experienced in loading.

4th. Four rounds at a target, distant 800 yards, the gun being loaded with empty common shell.

Remarks.—The tin cup was used as before, and with apparently the same result. No difficulty was experienced in loading for the first two rounds. In loading for the third round, however, there

App. No. 28.

there was considerable difficulty (apparently arising from the foulness of the chamber) in getting the felt wad home against the projectile. In endeavouring to effect this in the usual manner, two cartridges broke and had to be withdrawn. It was at last found necessary to drive the wad home first, and then enter the cartridge. In loading for the fourth round, the same difficulty was experienced with the loading, and the projectile of this round stripped, capsized, and fell about half way.

5th. One round at a target, distant 700 yards, the gun being loaded with empty common shell.

Remarks.—The ordinary lubricating wad, composed of lubricant and saw-dust, was used with a view of ascertaining whether any difference in the lubricating qualities of these and the felt wad would be apparent after a few rounds. In loading for the first round, some slight difficulty was experienced in getting the projectile home. The shell stripped, capsized, and fell about half way. The firing was now discontinued, with a view of ascertaining whether the foulness of the chamber, and consequently the projectile probably not going close home into its seat, was the sole cause of the stripping.

General Remarks.

During the day's practice the recoil of the gun was very moderate, about five feet, the outside compressors being alone used.

The gun worked well with a crew of 16 men.

4 June 1861.

During the preceding night, the gun was left without being cleaned, with a free current of air through the bore. This morning the deposit on the chamber and bore had partially dissolved, and had become very soft; the gun was consequently thoroughly cleaned without any difficulty. On examination, one slight longitudinal flaw was discovered on the left side of the chamber, one inch before the axis, its dimensions being ·92 × ·1 × ·2; the bore appeared in excellent condition; it was therefore considered that the foulness of the chamber, and, consequently, the projectile not being close home, was the sole cause of the stripping of yesterday.

Her Majesty's Ship "Excellent," 6 June 1861.

TRIAL of the Felt Lubricating Wads for the 100-pounder Armstrong Gun continued.

The following rounds were fired from a 100-pounder, No. 70, on board Her Majesty's steam tender "Stork," at Spithead. Charge, 12 lbs.; projectile, empty common shell.

1st Round.—In loading for this round, the chamber being perfectly clean and slightly greased, the rammer was carefully marked when the projectile was well home, with a view of ascertaining how far the foulness of the chamber in the rounds following interfered with the projectile gaining its seat. The gun was laid for a target distant 900 yards.

Remarks.—The tin cup was forced through the bore from breech to muzzle. This operation was performed with slight difficulty by three men, and occupied from 15 to 20 seconds. The deposit in the bore appeared hard, but of no thickness; the chamber was, however, very foul with thick hard scale, and appeared but very little broken away by the action of the cup in passing through the bore.

A quantity of loose hard scale, apparently a deposit from the cup, was left in the bore after the cup had been forced through.

2d Round.—In loading for this round, although every precaution was taken, the projectile did not gain its seat by ·9 of an inch. Some little difficulty was also experienced in getting the wad home. The gun was laid for the target distant 100 yards.

Remarks.—The cup was forced through the bore, as after the preceding round, and with apparently much the same result, the bore and chamber being in the same condition, the scale on the chamber being but little broken away by the cup.

3d Round.—Projectile not home by 1·1 of an inch. The gun laid for the horizon with 2 deg. elevation.

Remarks.—The tin cup was used as before, and with apparently the same result. The deposit in the grooves hard, but apparently not thick. Chamber as after the preceding rounds.

4th Round.—The projectile not home by one inch. The gun laid as for the preceding round.

Remarks.—The cup was used as in the former rounds, and with the same result.

5th Round.—Projectile not home by ·95 of an inch. The gun laid as before.

Remarks.—No apparent alteration in the condition of either bore or chamber.

6th Round.—Projectile not home by ·95 of an inch. The gun laid as before.

Remarks.—No apparent alteration in the condition of either bore or chamber.

The following rounds were now fired, using the wad composed of lubricant and sawdust, with a view to ascertain whether the lubricating qualities of this wad would affect the scale on the chamber.

The tin cup in rear of the charge was used each round, but was not forced through the bore.

1st Round.—The projectile not home by ·95 of an inch. The gun laid as for the preceding rounds.

Remarks.—No alteration in the condition of the bore. The scale on the chamber appeared thick and smooth.

2nd Round.—Projectile not home by 1·2 inch. Gun laid as before.

Remarks.—No alteration in the condition of either bore or chamber.

3rd Round.—Projectile not home 1·6 of an inch.

Remarks.—No apparent alteration in the condition of the bore or chamber.

4th Round.—Projectile not home by 1·4 inch. Gun laid as before.

Remarks.—Chamber apparently in the same condition, bore considerably leaded, globules of lead appearing on the sides of grooves to a considerable extent.

The weather becoming thick the firing was discontinued for about one hour, during which period the scale on the chamber appeared to have softened considerably.

5th Round.—

5th Round.—Projectile not home by 1·1 inch. Gun laid as before.

Remarks.—Chamber and bore in much the same condition; globules of lead very numerous in a considerable extent of bore.

6th Round.—Projectile not home by 1·1 inch.

Remarks.—Chamber and bore in apparently the same condition as after the previous round.

7th Round.—Projectile not home by 1·3 inch.

Remarks.—Chamber and bore in much the same condition; globules of lead not quite so numerous as after the two preceding rounds.

8th Round.—Projectile not home by 1·5 inch. Gun laid as before.

Remarks.—Chamber and bore in much the same condition; globules of lead very numerous in the bore.

9th Round.—Projectile not home by 1·4 inch. Gun laid as before.

Remarks.—Chamber and bore in much the same condition.

10th Round.—Projectile not home by ·9 inch; gun laid as before.

Remarks.—Chamber and bore in much the same condition. Globules of lead not quite so numerous in the bore. The firing was now discontinued, and the bore left without being cleaned, with a free current of air through.

General Remarks on this Firing.

During the practice, the recoil was very moderate, about five feet, the outside compressors alone being used.

It has been observed in all the practice with these guns, that the recoil of the first round is much sharper than that of the rounds following, and that the recoil gradually diminishes for the first half dozen rounds. These facts may, doubtless, be accounted for by the absence of lubrication in the bore, the increase of friction, and the consequent decrease of initial velocity.

Four of the projectiles on striking the water capsized, and continued their flight in a most irregular manner, the other ricochetted fairly the distance between the first and second graze, being, however, of great extent, and the entire flight tending considerably to the right.

From this day's experiment it appears evident that the felt wad, although not lubricating the chamber at all satisfactorily, is very far superior in lubricating qualities to the saw-dust wads, which, for this gun, seem to be utterly useless.

N.B.—The service-charge for this gun appears to be of an inconvenient length, viz., 14 × 5½ inches, for, although, when the chamber is perfectly clean, and the projectile close home into its seat, no inconvenience from this cause is experienced, but when the chamber is foul, considerable difficulty often occurs in getting the cartridge home, and, consequently, the vent-piece into its place.

— No. 17. —

Her Majesty's Ship "Excellent," 24 June 1861.

The following experiment took place with a view of ascertaining by what arrangement the hard scale that forms in the chamber of the Armstrong guns during firing might be best got rid of or softened, so as to avoid the inconvenience arising from its partially filling up and thus reducing the diameter of the chamber, and preventing the projectile gaining its seat. Gun, 100-pounder; register number, 71; charge, 12lbs.; projectile, empty common shell.

The gun was laid each round for a target distant 2,600 yards.

1st. Before loading for each round a 68-pounder sponge well soaked in tallow was forced into the chamber; the felt wad and cup was also used, but the cup was not forced through the bore.

When the projectile was close home the rammer was marked, in order, as far as possible, to ascertain the amount of the fouling.

No. 1 Round.—Chamber very foul; bore in fair condition.

No. 2 Round.—Projectile not home by ·7 of an inch; chamber and bore in apparently the same condition as after the first round.

No. 3 Round.—Projectile not home by ·7 of an inch; chamber and bore as before.

No. 4 Round.—Projectile not home by ·7 of an inch; chamber and bore as before.

No. 5 Round.—Projectile not home by ·7 of an inch; chamber and bore as before.

2d. The tin cup was now forced through the bore, and the gun loaded as before, the projectile not being home by ·5 of an inch.

In the following rounds the greased sponge was not used, but the tin cup forced through the bore after each round.

No. 1 Round.—Chamber very foul; the scale very little broken away by the action of the cup.

No. 2 Round.—Projectile not home by ·5 of an inch; chamber and bore as after the preceding round.

No. 3 Round.—Projectile not home by ·7 of an inch; chamber and bore as before.

No. 4 Round.—Projectile not home by ·8 of an inch; chamber and bore as before.

No. 5 Round.—Projectile not home by ·8 of an inch; chamber and bore as before.

No. 6 Rounds.—Projectile not home by ·7 of an inch; chamber and bore as before.

3d. After No. 6 Round the tin cup was thrust through the bore; a wet 68-pounder sponge was then forced twice into the chamber, and the gun loaded as before; this was repeated before loading for each of the following rounds:—

No. 1 Round.—Projectile close home; projectile stripped, capsized, and fell half way; chamber foul; bore in fair condition.

No. 2 Round.—Projectile close home; chamber and bore as after the previous round.

No. 3 Round.—Projectile not home by ·2 of an inch; chamber and bore as before.

App. No. 28.

— No. 18. —

TRIAL of the Shortened Slide for Pinnaces, 18 July 1861.

THE alteration in the rig of pinnaces necessitates the following reduction in the length of the foremost gun slides, in order that the gun may be traversed when the foremast is stepped.

32-feet Pinnaces.

	Ft.	in.
Length of old slide - -	8	5
„ New - - -	5	3½
Difference - - -	3	1½

28-feet Pinnaces.

	Ft.	in.
Length of old slide - -	6	7
„ New - - -	5	3½
Difference - - -	1	3½

With the foremast not stepped, the shortened slide will allow of a recoil of 3 feet, but with the foremast stepped, and the slide in line with the keel, the mast will not permit of a greater recoil than 15 inches.

The following experiment took place, with a view of ascertaining whether the slide, thwarts, &c., would bear without injury the increased severity of the shock caused by the great reduction in the amount of recoil.

The rounds were fired from an Armstrong pinnace gun, mounted in the bows of a new 28 ft. pinnace.

Charge, 1½ lbs.; projectile, empty segment shell. Gun laid horizontal, and in line with the keel; foremast stepped.

No 1 Round.—Breeching secured so as to allow of a recoil of 15 inches. Compressor hove up.

Remarks.—The breeching being new stretched, and permitted a recoil of 20 inches, the handle of the lever consequently took the mast, and injured it considerably, knocking off a piece about 6 × 2 inches.

Breeching very taut, but neither it nor bolts exhibited any signs of weakness.

No. 2 Round.—Breeching re-secured for 15 inches; recoil compressor hove up.

Remarks.—Through the breeching stretching, and the hitches giving out, the gun recoiled 17 inches, the handle of the lever consequently brought up again against the mast, and considerably injured it. Breeching very taut, slide apparently a little shaken, as shown by the opening of various small cracks in both the fore and rear part.

No. 3 Round.—Breeching again shortened up, so as to allow of 15 inches recoil. Compressor hove up.

Remarks.—Recoil very sharp; considerable strain on the breeching, as shown in its appearance in the various nips.

Four rounds were now fired without any apparent alteration in the condition of slide thwarts, breeching bolts, &c.

No. 8 Round.—Breeching being secured as before. Compressor hove up.

Remarks.—The stanchion supporting the centre of sailing thwart, on which the rear chock of the slide works, carried away, and the thwart drooped a little in the centre.

No. 9 Round.—Breeching and compressor as before.

Remarks.—Sailing thwart was found sprung in centre.

No. 10 Round.—Breeching and compressor as before.

Remarks.—Sailing thwart, badly sprung and rendered useless. The firing was therefore discontinued.

19 July 1861.

The following rounds were fired from the 12-pounder howitzer, mounted on the same slide, with a view of ascertaining whether the shortened slide was of sufficient length for the smooth bore gun.

From the absence of the breech screw, lever, &c., in the Howitzer, the slide when the mast is stepped will allow of a recoil of 2 feet 3 inches.

Six rounds were fired, the breeching being secured for a recoil of 2 feet.

Compressor hove up.

Remarks.—Breeching only just taut each round and with no undue strain upon it, slide bolts, &c. not in any degree strained or otherwise affected.

— No. 19. —

EXPERIMENTAL FIRING at Jones' Angular Butt, 21 August 1861.

THE experiment took place at Spithead, the same hulk, the "Griper," being used as on the former occasion, 4 August 1860.

The "Griper" was moored head S.W.

The "Stork" gunboat was moored abeam at 200 yards distant, at right angles to keel.

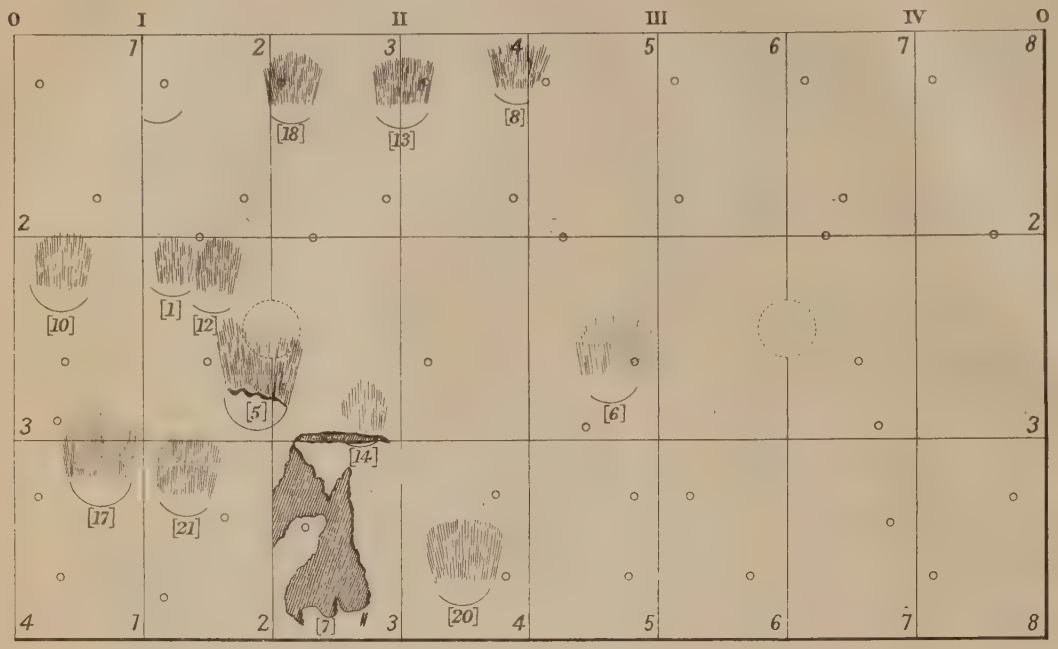
The target was composed of four plates of rolled iron from Messrs. Beale, Yorkshire, resting on the same butt used on 4th August, laid close to each other at an angle of 50° 53′ from the perpendicular, and rested on plates 15 inches wide by 1¾ thick, let into the backing of timber.

The plates Nos. 1 and 2 were 4½ inches, 3 and 4 5½ inches thick, and each one 7 feet by 3 feet, showing a vertical height of 4½ feet. They were secured to the 1 foot square balks of pine by screw bolts with conical counter-sunk heads, 1⅜ inch bolts.

Gun and Projectile.—The 100-pounder Armstrong

DIAGRAM OF PLATES BEFORE THE FIRING.

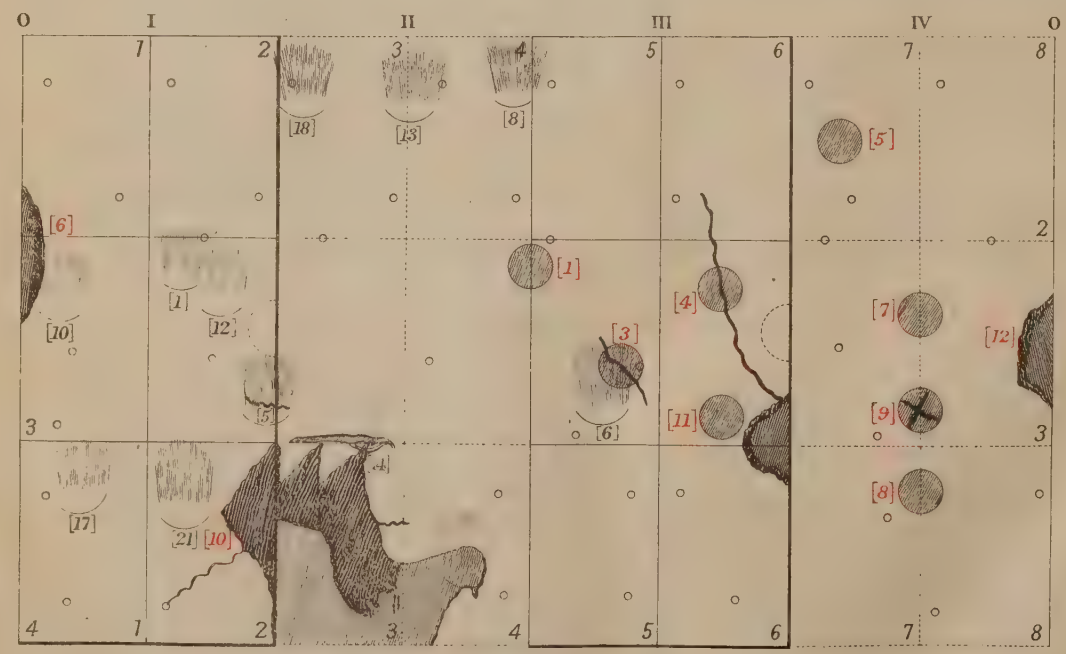
Dimensions of target 12 x 7 feet. Dimensions of each plate 3 x 7 feet.



SCALE ½ AN INCH PER FOOT.

DIAGRAM OF TARGET AFTER THE FIRING.

The N^os^ in Red ink and brackets, denote the indentations &c. caused by the round the N^o^ indicates.



The N^os^ in Black ink and brackets, show the effect of the rounds fired last August.

N^o^ 487. Ordered, by the House of Commons, to be printed, 23 July 1863

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strong gun was used, 81 cwt., with solid cast round-headed shot, 100 lbs., and fired with 14 lbs. of powder.

Results.—The first shot struck between 1 and 2 perpendicular, 2 and 3 horizontal. Diameter of impression, 6 inches; depth of indentation, 1 inch.

Target Ship.—No fracture in the plate. Lower edge of rolling from 4 to 5 deg:, impression clearly defined, upper not so, shot grazing up, two bolts broken out and three shaken. Centre of impression to farther broken bolt 2 ft. 3½ inches.

2d. Shot missed.

3d. Struck between 2 and 3 perpendicular; diameter, 6 inches; 3 and 4 horizontal; indentation, 1⅛ inches. Plate bulged in 1 inch from plane of No. 1 plate; four bolts started, the farthest being 5 feet 9 inches from hit.

4th. Struck outer part of wood framing, glanced under No. I. plate, and remained turned downwards.

5th. Struck between 1 and 2 perpendicular; diameter, 6 inches; and on 3 horizontal. Indentation, 1 inch. Plate slightly bulged in, and started up ¾ inch by No. 2 on top. Caused a crack across a bolt-hole six inches below of 7 inches length.

6th. No. III., 5½-inch plate.—Struck between 4 and 5 perpendicular; diameter, 6 inches; and on 3 horizontal; indentation, ⅝ inch. Three bolts in the same perpendicular division broken out.

7th. Struck between 2 and 3 perpendicular; diameter, 6 inches, and close above 4 horizontal; indentation, 1$\frac{1}{16}$ inch. Plate bulged in ½ inch.

8th. Struck between 3 and 4 perpendicular; diameter, 6 inches; 0 and 1, horizontal, indentation, 1 inch; grazing No. 3 plate.

9th. Missed, and struck ship's side.

10th. Struck between 0 and 1 perpendicular; diameter, 6 inches, and under 2 horizontal; indentation, 1½ inches, on a bolt which was driven in 1½ inches; no crack perceptible.

11th. Close on and above No. 7 impression; diameter, 6 inches; indentation, 1$\frac{5}{16}$; causing four cracks, radiating from No. 7, from 5 to 8 inches in length.

12th. Struck between 1 and 2 perpendicular; diameter, 6 inches; 2 and 3 horizontal; indentation, ⅞ inch; revealing a crack of 11 inches length and 1 inch depth across No. 5 to edge of plate.

13th. Struck on 3 perpendicular; diameter, 6 inches; between 0 and 1 horizontal; indentation 1¼ inches.

14th. Struck between 2 and 3 perpendicular, diameter 6 inches; and on 3 horizontal; indentation 1½ inches.

15th. Struck on and above No. 3, impression breaking out an irregular piece of plate, 8 inches by 6¼ inches, the lower edge at a bolt hole, and separated the layers for two feet.

Five shot fell within a space 1 foot 9 inches by 1 foot; between 2 and 3 perpendicular, 3 and 4 horizontal; upper edge of No. II. plate was now started up from 2 inches to 1 inch.

16th. Missed, and struck wooden framing under the left of No. 1 plate.

17th. Struck between 0 and 1 perpendicular, diameter 6 inches; 3 and 4 horizontal, indentation ¾ inch.

18th. Struck just to the right of No. 2 perpendicular, diameter 6 inches, between 0 and 1 horizontal, indentation 2⅛ inch, revealing a crack 7 inches long up to No. 13 impression, and causing four small cracks to a bolt-hole and the edge of the plate.

19th. Missed.

20th. Struck between 3 and 4 perpendicular, diameter 6 inches, and close above 4 horizontal, indentation ⅞ inch.

21st. Struck between 1 and 2 perpendicular, diameter 6 inches; 3 and 4 horizontal, indentation ¾ inch.

22d. Struck between 11th and 15th impression, making the sixth shot in a space of 1 foot 9 inches by 1 foot from centre shot, penetrating and completely breaking out, 2 feet by 1 foot 4 inches, of No. II. plate, and bulging in the framework underneath to the depth of 4 inches, pulverising the wood.

General Results of the Experimental Firing.

No. I. Plate. Six shot fell within the centre and lower divisions, 3 feet and 2 feet 4 inches, being the distance of centre of impressions; seven bolts were broken out from 4 to 6 inches, and the remaining seven started.

The lower edge of the plate was curled up 5 inches; a crack, of 11 inches length, made across No. 5 impression, and two small cracks, 1½ inches long, from bolt-hole, immediately below No. 5 impression.

The balks of pine under lower edge of No. I. plate were shattered by No. 4 and No. 16 shot, which penetrated under the plate, but as the plate was not struck afterwards on that part the damage was immaterial.

No. II. Plate was struck by 10 shot, 3 inches in the upper horizontal division 8, 13 and 18, at equal distances apart, 8 and 18 grazing the edges of the adjoining plates. The indentation of 18·2⅛ inch being greater than any other, except where the plate was broken.

Seven shot struck in the lowest horizontal division, six of these in the left section of it; the last (the 22d) of these completing the separation of part of this section from the plate, and causing extensive cracks radiating from centre of 10 impression; nine bolts were broken out of this plate, and the remaining three started. The framework immediately under the 6-shot impression was shaken, but not penetrated.

The right lower edge of plate was started up 2½ inches. The size of whole part knocked out was 24 inches by 16 inches; smaller fragment, 8 inches by 6½ inches; greater fragment, 18″ by 12″. The centre horizontal division was bulged up 3½ inches.

No. III. Plate was struck by one shot, No. 6, which made the least indentation of all, ⅝ inches; three bolts were knocked out, and one started.

All the shot appeared to break up on striking into numerous fragments, which generally fell between 500 and 1,500 yards beyond.

App. No. 28.

— No. 20. —

Her Majesty's Ship "Excellent," 18 September 1861.

The following experimental firing took place against the four plates that had formed the angulated target tested on the 21st of August last, with a view of comparing the effect caused by the impact of heavy projectiles on the plates when placed in a vertical position, with that when the plates were at an angle of 50° from the vertical.

The plates had not been disturbed since the trial of August, the target having been merely raised to a vertical position, and retained in this position by heavy balks of timber secured to the deck of the "Griper" and back to the target by strong iron knees.

The plates designated I., II., III. and IV. were of rolled iron, manufactured by Messrs. Beale of Parkgate, Yorkshire, I. and II. being 4½ inches and III. and IV. 5½ inches thick. They were placed in contact, and secured to 12-inch pine, backing by 1⅜-inch screw bolts with counter-sunk conical heads, flush with the surface of the plate, having a bearing in the timber of about 8 inches. With a view of rendering the edges of the plates less liable to be driven in by the impact of the projectile, strips of ⅝-inch iron were let in in the rear, thus rendering the backing on which the edges rested more solid.

The plates were all in perfect condition, except II., which was considerably shaken at the left-hand lower corner by the firing of August last.

The firing took place at Spithead, from Her Majesty's steam tender "Stork," moored at 200 yards from and right abeam of the "Griper."

Gun, Armstrong 100-pounder, 81 cwt. Charge, 14 lbs.

Projectile, cast-iron conical-headed solid shot, of 100 lbs. in weight.

No. 1 Round.—Hit direct on 4 vertical, and just below 2 horizontal, right in the wake of an iron beam, with half its diameter on II. plate and half on III. Shot broke up and fell back.

Indentation { Diameter, 6 inches.
Depth { on II. plate, 1⅝ inches.
on III. „ 1⅜ „

Four of the securing bolts of II. and III. plates broken, and a number of bolts considerably started.

No. 2 Round.—Hit direct on lower part of II. plate, the securing bolts having been all broken. The plate detached itself from the target, and fell on the deck.

No. 3 Round.—Hit direct III. plate, between 4 and 5 vertical, and below 2 horizontal, 12 inches from edge of plate. Shot broke up and fell back.

Indentation { Diameter, 6 inches.
Depth, 1¼ „

Bulge of plate, ⅝ of an inch.

One crack through indentation, 8 inches in length; plate considerably bulged in the upper part, having started from the backing 1⅜ of an inch. From the appearance of edge, it was evident that the layers composing the plate had not been intimately incorporated by the process of manufacture, as the shock of the impact caused them in some places to separate considerably, thus rendering the plate less solid.

No. 4 Round.—Hit direct III. plate, between 5 and 6 vertical and 2 and 3 horizontal, 1¼ inch from edge of plate, and 12 inches from indentation caused by No. 3 round. Shot broke up and fell back.

Indentation { Diameter, 7 inches.
Depth, 1¼ „

One crack, 14 inches long, right through indentation, and two cracks, extending from nearest bolt-hole to indentation, about 2 inches in length.

No. 5 Round.—Hit direct IV. plate, between 6 and 7 vertical, 6 inches from upper edge of plate. Shot broke up and fell back.

Indentation { Diameter, 7 inches.
Depth, 1⅜ „

Two of the remaining bolts of IV. plate broken, and several started.

No. 6 Round.—Hit direct on I. plate, on 6 vertical and 2 horizontal, with about ¾ of its diameter on plate. Broke off, and drove into the backing to the depth of 12 inches, an irregular fragment of plate, 18 by 20 inches.

No. 7 Round.—Hit direct on IV. plate, on 7 vertical and between 2 and 3 horizontal. Shot broke up and fell back.

Indentation { Diameter, 7 inches.
Depth, 1¼ „

Two securing bolts on extreme right of plate broken, remainder considerably started.

No. 8 Round.—Hit direct IV. plate, on 7 vertical and just below 3 horizontal. Shot broke up and fell back.

Indentation { Diameter, 6 inches.
Depth, 1⅛ „

One small crack was observed on the left-hand side of the plate, extending from the rear towards the surface about 2 inches in length. The plate bulged in 1⅛ of an inch, and started from the backing at the outer edge to the extent of about 2 or 3 inches.

No. 9 Round.—Hit direct on IV. plate, on 7 vertical and between 2 and 3 horizontal, 3 inches from indentation caused by No. 8 round, and 9 inches from that caused by No. 7.

Indentation { Diameter, 6 inches.
Depth, 1⅛ „

No. 10 Round.—Hit direct I. plate, on 2 vertical and between 3 and 4 horizontal, with its whole diameter on plate. Broke off, and drove into backing, to the depth of 10 inches, an irregular fragment, 17 by 24 inches. One crack, 14 inches in length, extending from fracture to bolt-hole.

No. 11 Round.—Hit direct III. plate, between 5 and 6 vertical and just above 3 horizontal, 12 inches from indentation caused by No. 4 round. Broke off, and drove into backing, to the depth of of 8 inches, an irregular fragment, 12 by 9 inches.

No. 12 Round.—Hit direct IV. plate, between 2 and 3 horizontal, with its whole diameter on edge

edge of plate. Broke off, and forced into backing to the depth of 12 inches, an irregular fragment, 17 by 7 inches.

Opened out considerably, and extended to 2 10 the crack caused by No. 9 round.

The securing bolts of IV. plate being all either broken or greatly started, and the plate consequently so insecure that it was considered advisable to secure it with a rope to the backing, in order, if possible, to prevent it falling overboard.

No. 13 Round.—Hit on IV. plate, which detached itself from the target and fell overboard.

—No. 21.—

Her Majesty's Ship "Excellent," 4 September 1861.

TRIAL of Carriage for the 20-pounder Armstrong Gun, intended for the broadside of Vessels of the "Pandora" class.

This carriage was constructed on the rear chock principle, and was precisely similar to those at present supplied for the above-mentioned purpose, except that the axis of the gun was raised nine inches higher.

Dimensions of Carriage:

Height of centre of trunnion boxes from deck - - - - - 3 ft.
Length of carriage - - - 3 ft. 6 in.

Gun, 21-pounder (naval service). Charge 2½ lbs. Projectile, solid shot, 26 lbs.

First round. Breeching secured so as to allow of a recoil of 2′ 3″.

Remarks.—Recoil very violent, and most unsteady, showing a great tendency to capsize, the rear chock rising off the deck about 18 inches as the carriage was brought up by the breeching.

Second round. Breeching secured so as to allow of a recoil of 2′ 7″.

Remarks.—As in the former round, the tendency to capsize being rather increased.

3d Round. Breeching secured so as to allow of a recoil of three feet.

Remarks.—As in the former rounds, the tendency to capsize evidently increasing considerably.

Three rounds were now fired, the gun being mounted on the ordinary top and bottom carriage.

Height of centre of trunnion boxes, 2 ft. 6½ in.
Extreme length of bottom - 4 „ 3 „

The breeching was secured so as to allow of a recoil of three feet.

Remarks.—Recoil violent, but steady, no tendency to capsize being apparent.

25 September 1861.

Trial of Broadside Carriage for the 20-pounder Armstrong gun continued.

Received on board, the broadside carriage intended for a 20-pounder Armstrong gun, the trial of which took place on the 4th of September; it had undergone the following alterations with a view of rendering the recoil more steady.

Carriage lowered bodily one inch, which was effected by reducing the diameter of the trucks one inch by taking one inch from the thickness of the rear chock.

The rear chock thrown back 8 inches, and the cheeks or sides of carriage lengthened to the rear 8½ inches.

The 20-pounder gun was mounted, and four rounds fired, breeching being secured so as to allow of a recoil of three feet.

Charge 2½ lbs. Projectile, solid shot, 26 lbs.

Remarks.—Recoil sharp, but much steadier than during the last trial, before it had undergone the above-mentioned alterations; it exhibited no tendency to capsize, and was easily worked. It was not, however, as steady as could be wished, as the rear chock jumped off the deck about three inches as the gun was brought by the breeching.

The gun was now dismounted, and the carriage returned for further alterations.

—No. 22.—

Her Majesty's Ship "Excellent," 2 October 1861.

TRIAL of the Broadside Carriage for the 20-pounder Armstrong Gun continued.

The following alterations having been effected since the last trial:—

Axis of gun lowered two inches. Length of fore axletree increased four inches.

The gun was mounted and the following rounds fired, breeching being secured so as to allow of a recoil of three feet.

First four rounds with solid shot of 26 lbs. Charge, 2½ lbs.

Result.—Recoil steady, but very severe; the fore trucks rising off the deck about an inch as the gun was brought up by the breeching.

Second three rounds with empty shell of 21¾ lbs. Charge, 2½ lbs.

Result.—Recoil steady, and very moderate.

The gun was now dismounted, and the carriage returned for further alterations.

3 October 1861.

The following alterations having been effected since the last trial:—

The cheeks of the carriage lowered to the rear 2½ inches.

App. No. 28.

The gun was mounted, and the following rounds fired, breeching secured as before.

Four rounds with solid shot of 26 lbs. Charge, 2½ lbs.

Result.—Recoil very steady and sharp, but not so violent as during the previous trials. On firing the fourth round, through the breech-screw not being properly screwed up, the vent-piece was blown out with great violence, struck the carline immediately overhead, broke off its own cross-piece and handles, and shivered the carline; the deck was filled with smoke; several bulkheads blown in, and a considerable quantity of glass broken.

The trial was for the present discontinued.

4 October 1861.

The trial of the Broadside Carriage of the 20-pounder Armstrong was this day resumed.

First two rounds using solid shot of 26 lbs.; charge, 2½ lbs.; the breeching being secured so as to allow of a recoil of three feet.

Result.—Recoil steady, but very sharp, though considerably less violent than before; the cheeks of the carriage had been lowered to the rear; the fore trucks however jumped off the deck two or three inches, which was considered highly objectionable.

Second two rounds with the same charge, the breeching secured so as to allow of a recoil of four feet.

Result.—The increased length of breeching appeared to make but little difference in the state of the recoil, as the gun jumped objectionably before the breeching was taut.

The gun was now dismounted, and the carriage returned for further alterations.

1 October 1861.

Trial of the Broadside Carriage for the 20-pounder Armstrong gun continued.

The following alterations having been effected since the last trial:—

Trunnion boxes shifted 4 inches farther to the rear.

Rear chock - { Length increased by 4 inches. / Breadth „ 2 „

The gun was mounted, and the following rounds fired, the breeching being secured so as to allow of a recoil of 3 feet.

First five rounds using the solid shot of 26 lbs.

Result.—Recoil exceedingly sharp but steady, exhibiting a very marked improvement since the last trial; it was, however, not considered quite satisfactory, as the fore trucks displayed some tendency to rise from the deck as the gun was brought up by the breeching.

2nd two rounds using the empty shell of 21¾ lbs., the fore trucks having been removed for the last round.

Result.—No perceptible difference in the violence of the recoil; the removal of the trucks, however, rendered it considerably less steady.

The gun was dismounted, and the carriage returned for further alteration.

8 October 1861.

Trial of the Broadside Carriage for the 20-pounder Armstrong gun continued.

The following alterations having been effected:—

Trunnion boxes.—Shifted out 2 inches, thus bringing the weight of the gun more directly on the fore axletree.

Cheeks of carriage.—Lowered to the rear 1 inch.

The gun was mounted, and the following rounds were fired, with the undermentioned result, the breeching being secured so as to allow of a recoil of 3 feet:—

1st five rounds, using solid shot of 26 lbs. Charge 2½ lbs.

Result.—Recoil very sharp but steady; the tendency of the fore trucks to jump off the deck, a good deal lessened.

2nd. The breeching was now rove in a hole in the carriage, 10 inches to the rear of the usual position.

One round, using the same projectile and charge.

Result.—Recoil very sharp and considerably less steady; the fore truck jumping off the deck in a very objectionable manner.

The gun was now dismounted, and the carriage returned for further alterations.

15 October 1861.

The following alterations having been effected:—

Rear chock removed 6 inches to the rear.

The gun was mounted, and the following rounds were fired with the undermentioned result, the breeching being secured so as to allow of a recoil of 3 feet.

Six rounds, using solid shot of 26 lbs. Charge 2½ lbs.

Result.—Recoil sharp but perfectly steady. The fore trucks displayed no tendency to rise off the deck, neither was the gun thrown out of position by the strain on the breeching as the gun brought up.

This result was considered satisfactory; the gun was therefore dismounted, and the carriage sent to the gun wharf as a pattern for further supply.

Dimensions of Carriages.

		Ft.	*in.*
Extreme length		4	5
Height of centre of trunnion boxes		2	8
Rear chock	Length	3	5
	Width	0	12¼
	Thickness	0	7¼
Elevation and depression that the carriage is capable of giving with elevating screw-	17° elevation. 6° depression.		

The following alterations have been effected on the original carriage sent on board for trial on the 4th of September:—

		In.
Centre of trunnion boxes lowered		4
Length of carriage increased		11
Rear check	Thrown back	14
	Length increased	4
	Breadth increased	2
Cheeks of carriage lowered to the rear		3½
Length of fore axletree increased		4
Diameter of trucks reduced		2

— No. 23. —

Her Majesty's Ship "Excellent," 7 October 1861.

In consequence of an order received from the Admiralty to report whether this sponge with the flat solid head would answer the purpose of a rammer, as well as that of a sponge, it was tried in the following manner, and with the undermentioned result.

Gun, 100-pounder, mounted on the naval pivoting carriage.

A shot was rammed home by the ordinary numbers, as laid down in the instructions at different positions of the gun with respect to elevation.

The sponge was found to answer well, sending the shot close home into its seat, no inconvenience at ordinary elevations, up to 10°, being experienced either from its length or weight; above this elevation the staff of the sponge takes the slide, and cannot be used until the position of the gun is altered.

— No. 24. —

Her Majesty's Ship "Excellent," 23 October 1861.

The 20-pounder Armstrong gun was mounted on the ordinary boats carriage, in a 42-foot launch, and the following rounds were fired with a view of satisfactorily ascertaining whether the recoil of this gun thus mounted, could be easily controlled on the slide with the assistance of the compressors, and further, whether it was probable that the gear, &c., was of sufficient strength to stand continual rapid firing.

Projectile, solid shot, 26 lbs. Charge, 2½ lbs.

Gun laid horizontal:

1st two rounds. Breeching secured so as to allow of a recoil of 3 feet. Compressors hove up.

Result.—Recoil sharp, breeching taut, but apparently no undue strain was brought upon it.

2d four rounds.—Breeching secured so as to allow of a recoil of 2 feet 6 inches. Compressors hove up.

Result.—Recoil sharp, breeching taut, but apparently no undue strain was brought on any part of the gear.

3rd, one round.—Breeching secured so as to allow of a recoil of 4 feet. Compressors hove up.

Result.—Breeching quite taut.

4th, one round.—Breeching secured so as to allow of a recoil of 5 feet. Compressors hove up.

Result.—Breeching not taut.

Remarks.—From the above and from former experiments, it would appear that with 3 feet recoil, no undue strain is brought on any portion of the gear. And further, that the extreme recoil (compressors being hove up) without the breeching, would be certainly under 6 feet, the rear of the gun would then clear the mast by 9 inches.

The weather becoming thick, a further trial could not be carried on.

— No. 25. —

Her Majesty's Ship "Excellent," 2 December 1861.

Trial of the fittings of the 6-pounder Armstrong gun, 3½ cwt., proposed as the armament of 32-feet cutters.

The gun was mounted in the bows of a 32-foot cutter belonging to Her Majesty's Ship "Edgar," fitted for its reception by the dockyard. The carriage was in every way similar to the ordinary carriage supplied for boats' service; but had neither guide, compressor plates, or compressor, being fitted in lieu of these with two screw guide-bolts, one in front of the carriage, and one just before the elevating screw; these bolts worked in the slot through the centre of the slide, keeping the carriage square on the slide. The side tackles, breeching-bolts, &c., were fitted in the usual manner, the breeching-bolts being half inch.

The following rounds were fired, with a view of testing the fittings, &c.

Charge, ¾ lbs. Projectile, empty segment shell.

1st, one round.—The breeching being secured so as to allow of a recoil of 3 feet. Gun laid horizontal; boat on an even keel.

Result.—Recoil sharp but steady taut breech; the gun exhibited no tendency to jump off the slide. No complaining in the gear, &c. Gun worked with great ease.

2d, four rounds.—The breeching being secured so as to allow of a recoil of 2 feet. Gun laid horizontal.

Result.—Recoil sharp but steady.

After the last round, the left hand breeching-bolt appeared to be considerably started.

3d, three rounds. Gun laid horizontal.

Result.—As in the previous rounds, with the exception of the breeching-bolt already mentioned, the gear stood well, and the gun worked with great ease.

General Remarks.

The gun appears well adapted for the armament of these boats, and the fittings suitable; no compressor being required, and the guide-bolts answering well in lieu of guide-plates. The following alterations are recommended with a view of rendering the fittings more efficient:—

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1stly.—With a view of preventing the gun jumping off the slide in a heavy sea-way or otherwise, screw-nuts on the lower extremities of the guide-bolts working about half an inch clear of the lower face of the slide.

2dly.—For the better securing of the breeching, the size of the breeching-bolts to be increased to five-eighths of an inch.

Note.—The eye-bolts for the breeching-rings should be always secured with the eye horizontal, in order that the strain brought by the recoil may be fair with the shoulder of the bolt. In the cutter tried to day, the bolts were secured with the eyes vertical, which brought a very undue strain on the bolt, and this must be considered a very faulty fitting.

Amount of recoil recommended to be used, and also the amount that the slide will admit of:—

In order to avoid strain of boat, &c., the recoil should not be less than 2 feet 6 inches.

The slide allows of a recoil of 4 feet 6 inches.

With the foremast stepped, and gun in line with keel, 4 feet.

— No. 26. —

Her Majesty's Ship "Excellent," 30 December 1861.

Report on Naval Field Carriages for the 20 and 12-pounder Armstrong Guns, fitted with detached elevating screws and traversing arrangements.

Two of the above-mentioned carriages were received on board for trial and report on the 28th of November; they have been, consequently, upwards of one month under continual trial.

From observations made during this period, it is considered—

1st. That the traversing arrangement is a great advantage, and very necessary for extremely accurate pointing.

2d. That the detached elevating screws work extremely well, and that in consequence of the increase of elevation obtainable, and also of the greater facility of working, &c., screws thus fitted are very superior to those fitted with the elevating eye.

3d. That the carriages are well adapted for field service, and that the guns can be manœuvred with ease, by the established crews.

Report of the Top Carriage (Boats' Service) for 20 and 12-pounder Armstrong Guns fitted with detached elevating screws.

These carriages have been under trial for some months and are highly approved of, every portion being of the requisite strength, and the recoil of the guns being perfectly controllable by means of the compressor.

The detached elevating screws are considered (for the reasons mentioned in the report of the field carriages) a great improvement on the screws fitted with the elevating eye.

— No. 27. —

Her Majesty's Ship "Excellent," 10 January 1862.

Report on Bristle Sponges.

Received on board on the 20th July 1861, for trial and report, two bristle sponges for the 100-pounder Armstrong Gun.

These sponges have been in constant use ever since, and are found to possess in a very high degree the following valuable properties:—

1st. Capacity for thoroughly cleansing the bore, &c.

2d. Great durability.

With respect to the first of these, it must be noted, that tow has always been used in combination with the bristles, a small quantity being wound round the head of the sponge; this has been found to answer very well, the bristles keeping the tow well up to its work in the grooves.

With respect to its durability, it is sufficient to state, that the sponges have hitherto exhibited no sign of wearing out, the bristles still retaining a requisite degree of stiffness although constantly exposed to the weather, and (for the purpose of lubricating the grooves, &c.) continually soaked in oil and grease.

The aforementioned sponges are high, the bristles one inch long, and placed close together.

Report of a Bristle Sponge received for trial and report on the 10th December.

The sponge under consideration is fitted as follows, according to the recommendation of Captain Hewlett:—

Head solid, with a view of forcing the tin cup through the bore after the discharge, also in order that it might be used as a rammer when required.

Bristles three-quarters of an inch in length and placed in open rows (half an inch between each row) round the sponge head, which is made of the requisite diameter, so as to keep the bristles well up to their work in the grooves.

Remarks.

This sponge has been in constant use for one month, and is found to answer well, being admirably adapted for cleansing the bore after practice, a small quantity of tow or oakum wrapped round the head, in the opening between the rows of bristles, being all that is required; this tow, &c., can be removed without the least trouble or loss of time as often as necessary.

In forcing the tin cup through the bore, the bristles act well, carrying out whatevever of scale, &c., may have been broken away by the cup.

The sponge has also been used as a rammer at various positions of the gun with respect to elevation, and has been found to answer well, sending the projectile home readily, no particular inconvenience having been experienced either from

from its weight or length, except when the gun has extreme elevation; then it cannot be used until the position of the gun is altered.

Judging from the wear of the other two bristle sponges that have been in use for some months, it is considered that the durability of this sponge will be very great.

— No. 28. —

Her Majesty's Ship "Excellent," 10 January 1862.

Report on the improved Cleaning Rods for the Armstrong Guns.

Received on the 2d December 1861, for trial and report, improved cleaning rods as follows:—

For the 12-pounder - One in number.
„ 20 „ „ „

These rods have been in constant use ever since, and from observations made during this period it is considered:

1st. That with clean tow or oakum wrapped round their heads, so as to make them sufficiently high; they answer the purpose for which they are intended very fairly.

2d. That unless clean tow or oakum is wrapped round their heads, as before-mentioned, each time they are used, they are utterly useless, not being sufficiently high to take the grooves, and at once becoming completely sodden with moisture and dirt.

3d. That their value for cleaning the guns is about equal to the ordinary sponge when the latter has tow wrapped round it, but inferior to the bristle sponge for not possessing the spring requisite to keep the tow up to its work; in the grooves, when of an easy fit, it is necessary to make them very high in order that they may act at all effectively, thereby considerably increasing the difficulty of using them; also that the new tow placed on their heads does not adhere so well as it does on the bristle sponges.

4th. That when carefully used as above-mentioned, they will last without being renewed for a considerable period, probably 12 months; but if allowed to become wet and sodden, they will quickly rot.

That they can be renewed without difficulty if the material for constructing them (tow) is at hand, but that they cannot be made readily from oakum.

— No. 29. —

Her Majesty's Ship "Excellent," 4 February 1862.

Received on board for trial and report, a complete set of Captain Lyon's improved Cleaning Rods for the Armstrong Guns, the set consisting of one rod for each description of gun.

The heads of these rods are very similar in construction to those reported upon on the 10th of January last, the chief difference being that with the latter, the tow forming the head is wound round between the pins and then secured by bands of tow which are rove through eyes in the rod head; in the rods under consideration, the tow is merely wound round between the pins, no securing bands, the ends of the tow being merely tucked in; the cup-like shape of the staff just below the head prevents the tow from slipping down.

These rods have been in constant use ever since, and have been found to answer well the purpose for which they are intended (cleaning the bore); that when used with care, and not allowed to get sodden with wet and dirt, they are sufficiently durable; that they can be renewed with great ease as often as required, there being, however, no bands used in the construction of the head; tow of long fibre is necessary for this purpose, common brown oakum being a most indifferent substitute.

That the cup-like shape of the lower part of the head appears to be an improvement, and answers well, keeping the tow forming the head well up on the staff. The absence of the tow bands on the head is of some slight inconvenience, as the tow does not remain so snugly on the head as when bands are used. This is, however, considered of little consequence compared with the great facility with which the heads of cleaning rods thus fitted can be renewed.

— No. 30. —

Trial of Captain *Coles'* Shield, fitted to contain two 100-pounder Armstrong Guns.

The following trials took place with a view of ascertaining the undermentioned points with respect to the Shield in question.

1st. Whether the internal diameter, 15 feet 6 inches, gave space sufficient for conveniently working the guns.

2d. Whether it was probable any injurious effects or any great inconvenience would arise from the concussion caused by the firing of such heavy guns in so confined a space.

3d. Whether it was probable that the smoke would accumulate in the shield to such an extent as to inconvenience the guns' crews.

4th. Whether the carriage fittings, &c., were suitable, and in all respects well adapted for general service.

This latter point was, however, judged to be more properly a subject of a future consideration, it being considered that extended experiments and familiarity with the weapon were absolutely neces-

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sary in order to work out satisfactorily the best requisite strength, &c., of the peculiar fittings connected with carriage and shield, and the experiment proved that the required alterations were very few and of little moment.

The shield, constructed of heavy timber, was placed on the upper deck of the hulk "Hakard," well secured, and the deck shored up underneath. It was in all points essential to the satisfactorily carrying out of the trials, similar to the shield it was intended to represent, differing from it merely in being constructed of wood, in being secured to the deck instead of being placed on a turntable, in having certain portions of its structure intended to be below the upper deck, above instead, thus raising the entire shield five feet.

Dimensions of Shield.

	Ft.	*in.*
Internal diameter - - - -	15	5
Scantling, about - - - -	2	–
Intended height above upper deck -	4	3

The guns, two 100-pounders, of 90 cwt., constructed on purpose for the shield, different from the ordinary 100-pounders in being smooth and conical in form from the trunnions out, and in consequent weight, they were placed side by side, five inches apart, and mounted on Captain Coles' inclined plane carriage, and breeched so as to allow of a recoil of from three to four feet.

The dimensions of the ports were about 3 3 × 2 6, which, combined with the peculiar construction of the carriage, permitted the following elevation and depression :—

Elevation, extreme - - - -	14°
Depression ditto - - - -	4½°

A very slight alteration in carriage and port would enable the gun to give 18° elevation and 6° depression.

1st Trial.—18 February 1862.

The guns' crews being told off and stationed, the guns, without any difficulty, were loaded.

Charge, 12 lbs. Projectile, empty shell, 104 lbs.

Elevation 7° 30′. Target distant, 2,600 yards.

Ship on an even keel; a fresh breeze, with the range force about 4.

1st. One round from each gun at the above-mentioned target.

Remarks.—Both guns recoiled steadily up the inclines sharply to a taut breeching to the extent of from 3′ 6″ to 3′ 9″. The right gun went easily down the incline to about six inches of its proper position when out. The left gun went down with some violence, rebounding back about 8 inches; both guns were easily run out.

No inconvenience whatever was experienced from the concussion, and there was no accumulation of smoke of any consequence in the shield. Both guns worked very readily.

Through default in the material, the metal seating of the elevating screw of the right gun broke, and the elevating arrangement was thus temporarily rendered useless.

2d. Four rounds of steady independent firing from the left gun, at the same target, with the same projectile and charge.

Remarks.—At each round the gun recoiled steadily up the incline about 3′ 9″ to a taut breeching, then down, without any great violence, rebounding back to about six or eight inches. The concussion was considered most moderate, no inconvenience whatever being experienced from it. No accumulation of smoke. The gun worked readily, and the gear did not complain.

2d Trial.—21 February 1862.

The elevating arrangement of the right gun having been repaired, the follow rounds were fired, with precisely the same objects in view as on the preceding day.

Projectile, solid shot, 110 lbs.; charge, 14 lbs.; elevation, 7° 50′; distance of target, 2,600 yards.

Wind, fresh breeze, with the range force from four to five.

First. One round on independent firing from each gun.

Remarks.—Guns recoiled sharply from 3′ 6″ to 3′ 9″ to a taut breeching, and run out again without any great violence, the "right gun" not running out by some six or eight inches, and the left gun running out and back again some six inches.

Both guns worked readily, and were run out with ease.

No inconvenience was experienced from the concussion, neither was there any accumulation of smoke in the shield.

Second. Both guns were fired simultaneously at the same object.

Remarks.—The right gun recoiled steadily to a taut breeching, to the extent of four feet, then close out, where it remained.

The left gun recoiled sharply 3′ 9″ to a taut breeching, going down the incline with some little violence, and rebounding some six or eight inches.

The breeching shackles in the carriage of the right gun complaining, it was considered desirable to discontinue the practice with this gun till the faulty fittings could be altered; some very slight inconvenience was experienced from the concussion of both guns fired simultaneously, and there was not the least accumulation of smoke.

Third. One round from the "left gun" at the same target, and with the same charge.

Remarks.—No inconvenience was experienced from the concussion, neither was there any accumulation of smoke.

The breeching shackles of this gun also complaining, it was considered desirable to discontinue the practice until the faulty fittings could be altered.

Third Trial.—1 March 1862.

The breechings being fitted differently, and in a much more serviceable manner, the following rounds were fired:

Projectile, solid shot, 110 lbs.; charge, 14 lbs.; elevation, 7° 50′; distance of target, 2,600 yards.

Breeze moderate across the range, ship heeling towards the object ½°.

With a view of stopping the draught in the shield, and thus causing the smoke to accumulate, the top was covered with tarpaulins, except a small opening over each slot, also one in rear of and between the guns, for the head and shoulders of the captain of the gun; the sides of the shield were also covered in, leaving two small openings in the rear of the guns, for the convenience of supplying ammunition; the shield was thus entirely covered in, except for the space of about 5 × 3 feet, and all appreciable draught prevented.

With

With a view of more effectually testing the force of concussion, two fighting lanterns were lighted, and suspended in rear of and 4′ 6″ from the axis of the guns.

First. Two rounds from each gun, of steady independent firing.

Remarks.—Both guns worked very satisfactorily, recoiling sharply, but steadily, up the inclines, then back without any very great violence. It was noticed that the "left gun," on coming down the incline, invariably went close out and then back for about six or eight inches, whereas the "right gun" never went out of itself by about six inches; this peculiarity was supposed to result from some slight difference in the inclines.

No inconvenience whatever was experienced from the concussion, which appeared very moderate, neither was there any accumulation of smoke in the shield. The breechings of both guns being new, gave out a little, and had to be taken up some six inches on each end.

Second. One round from each gun fired simultaneously.

Remarks.—A very slight inconvenience from the concussion, &c.; no accumulation of smoke; guns worked satisfactorily.

Third. With a view of particularly testing the controlling power of the compressors, three rounds from each gun at the same target, and with the same charge, compressors set up moderately taut.

Remarks.—Guns recoiled about three feet, not tautening the breeching, and did not run out about nine inches; it was observed that the guns recoiled up the inclines very steady, but appeared rather unsteady in going down, the rear of the carriage jumping considerably; this peculiarity was supposed to result from the legs of the breeching not being exactly equal in length.

The elevating screws of both guns were considerably and injuriously affected; the metal seating of that of the "left gun" was completely broken, and the ratchet collar of the "right gun" rendered immoveable; both these accidents were attributable to faulty fittings.

Fourth. With a view of ascertaining with what probable rapidity the gun could be worked, six rounds of independent firing from the "right gun" at the same target, and with the same charge.

Remarks.—This was performed easily in about eight minutes, and the practice was very good; it was considered that had the shield been moveable, instead of a fixture, the six rounds might have been fired in considerably less time, as the captain of the shield had to wait each round till the swinging of the ship brought the target on, instead of, if the shield had been moveable, bringing it on while the loading was being performed.

The guns worked most satisfactorily; all the fitting appeared of the strength requisite, except the elevating screws, which, through faulty fittings, were considered far too weak for the work. No inconvenience from the concussion, and no accumulation of smoke.

— No. 31. —

Her Majesty's Ship "Excellent," 13 March 1862.

Trial of Lieutenant Colonel *Boxer's* Lubricators for the Armstrong Guns.

The following experiment took place with a view of ascertaining whether, when using Lieut.-Colonel Boxer's lubricators with the Armstrong guns, the application of the sponge would be necessary during the practice.

The Armstrong 40-pounder, register No. 155, was picked out as the gun to make the trial with, and as the copper ring in rear of the chamber was in some places slightly worn, in consequence of it having been in constant use for many months, both for exercise and practice, it was refaced in the usual manner; the breeching was secured so as to allow of a recoil of 3 feet, and 100 rounds were then fired as rapidly as possible, consistent with the correct laying and working of the gun; after every 25 rounds every portion of the gun-carriage, &c., was carefully examined, Boxer's lubricators and cartridge being used during the practice, and the gun never sponged.

Charge, 5 lbs.; projectile, solid shot, 40 lbs.

Remarks.

First 25 rounds.—These rounds were fired in 24 minutes, making most excellent practice at a target distant 1,800 yards. No difficulty whatever was experienced in the loading, and the lubricator attached to the cartridge was found greatly to facilitate its performance. The usual hard deposit was observed in the chamber, and a thin hard scale in the grooves and on the lands; these, however, did not appear to increase in thickness, neither did the deposit in the chamber interfere in the least with the projectile gaining its seat. A small circular flaw was observed in bore about 8 inches from the muzzle, extending apparently with the coil about one-fourth round; this was, however, of no moment whatever. The chamber was perfectly cool, both internally and externally, the chase being the only part of the gun at all warm. The recoil was sharp, but steady. No portion of the gear appeared in the least distressed.

Second 25 rounds.—These rounds were fired in 20 minutes, making exceedingly good practice at the 1,800 yard target. The loading, &c., was performed with the greatest facility, the projectile gaining its seat most readily; the deposit in the chamber and grooves did not appear to increase in thickness; no appearance of lead in the grooves, and the flaw in the bore did not spread. The chamber, both internally and externally, was warm, and the chase so hot that it was difficult to bear the naked hand upon it. Recoil sharp, but steady; slightly increasing in violence. No complaining in any portions of the working gear of gun or carriage.

Third 25 rounds.—These rounds were fired in 19 minutes, and the practice was most excellent at a target distant 2,600 yards. The loading, &c. was performed with the greatest facility; the deposit in the chamber and grooves did not appear to increase in thickness, and the flaw in the bore

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did not spread. The chamber and the other portions of the gun were now excessively hot; the breech was found to work rather stiffly; it was consequently lubricated slightly in the usual manner, and then worked most satisfactorily. Recoil sharp, but steady; the breeching had given out some 12 inches, but did not complain. After the last round, the copper ring of the vent piece fell off; it was considered that this was caused by the unequal expansions of the two metals; this vent piece, No. 167, had fired 262 rounds, and although temporarily disabled by the loss of the ring, was otherwise in perfect condition. A spare vent piece was used for the remaining 25 rounds.

Fourth 25 rounds.—These rounds were fired in 22 minutes, and the practice was most excellent at the 2,600 yard target; the loading, &c., was performed with the greatest facility, and no difficulty whatever was experienced in either getting the projectile home or working the breech. The deposit in the chamber, &c., did not appear to increase in thickness, nor the flaw in the bore to spread. The gun was exceedingly hot all over, and the recoil was sharp, but steady, being by no means excessively violent.

Every portion of the gun and carriage was now thoroughly and carefully examined, and (with the exception of the tangent sight) was found in perfect order; the tangent sight was bent a little forwards, but after the practice, was with ease straightened. One hundred rounds had now been fired in rather less than 90 minutes; and the application of the sponge during the practice had been considered quite unnecessary.

Trial of Lieutenant Colonel *Boxer's* Lubricators continued.

18 March 1862.

With a view of still further testing the efficiency of Lieutenant Colonel Boxer's lubricators, 20 rounds were fired from an Armstrong 100-pounder, at a target distant 2,600 yards; the firing was carried on as rapidly as possible, consistent with a correct laying and working of the gun; and the examination of the bore, which was carefully performed after every round, the rammer being also marked in order to ascertain how far the scale in the chamber would interfere with the projectile gaining its seat.

The sponge was not used during the practice, and the tin cup was extracted through the slot.

Projectile, empty plugged shell; charge, 12 lbs.

Remarks.—Throughout the practice, the chamber exhibited the usual hard scale, which, however, after the first few rounds did not appear to increase in thickness. A hard thin deposit also appeared in the bore; this however did not increase in thickness, nor was there the slightest appearance of lead. The projectile, after the first round, failed to gain the seat it occupied when the chamber was perfectly clean, by from ·6 to ·8 of an inch; it was, however, considered that this was caused more by the increase of friction, and the consequent difficulty of setting home the projectile, than by any material filling up of its seat.

The loading was performed with comparative ease, and the practice at the target was most excellent.

—No. 32.—

Her Majesty's Ship "Excellent," 16 April 1862.

Received on board for trial and report, a 9-pounder Armstrong gun, proposed as an armament of barges and pinnaces, and also for field service.

Table showing Weight, Length, and other Particulars of the 9-pounder under consideration, and also of the 12-pounder (S. S.) the gun at present issued to the Naval Service for the above mentioned purposes.

	12-pounder, Sea Service.	9-pounder.
	Cwts. qrs. lbs.	*Cwts. qrs. lbs.*
Average weight	8 0 24	6 0 0
Length of gun (over all)	6′ 0″	5′ 2″
Length of bore	4′ 5″	3′ 9¼″
Length of chamber	0′ 8·5″	0′ 7″
Diameter of bore (calibre)	0′ 3″	0′ 3″
Diameter of chamber	0′ 3·125″	0′ 3·2″
Service charge	1 lb. 8 oz.	1 lb. 2 oz.
Projectile, length of	6·91 inches	5·43 inches.
Projectile, weight of	10¾ lbs.	8¼ lbs.
Projectile, number of segments	49	41

The following experiments took place in order to ascertain how far the gun was suited for the purposes for which it was proposed.

1st. With a view of noting, the facility of loading, the amount of recoil, &c., and also of gaining some idea of its range and accuracy, compared with that of the 12-pounder (S. S.).

The gun was mounted on a common top and under carriage, and placed on a fixed platform; the breeching (1 inch) secured so as to permit of a recoil of three feet; 20 rounds were then fired at different targets, 1,000, 1,800, and 2,600 yards distant respectively from the gun.

Result.—Recoil moderate and steady to a taut breeching (3 feet). Practice very good, but (as was expected) the gun required considerably more elevation for the same distance than the 12-pounder (S. S.) The loading was very easy, and in this respect (due to the small increase in the diameter of the chamber) it appeared to possess some slight advantage over the 12-pounder.

2d. With a view of ascertaining the amount of difference in the immersion of the bow of the boat caused by the decrease of 2 cwt. in the gun, also with what facility the 9-pounder could be worked when mounted in the bows of a boat, and whether the ordinary fittings were suitable for the gun, both guns were mounted in the ordinary manner in the bows of the 28-feet pinnace; and, by accurate measurement, it was ascertained that with the 9-pounder the immersion was one inch less than with the 12-pounder. It must be noted that the boat was not considered at all over pressed with the 12-pounder.

Four rounds were then fired with the 9-pounder, the breeching being secured so as to permit of a recoil of three feet, and the compressor hove up every round.

Result.—Recoil very easy and steady to about 12 inches.

The gun was worked with great facility; the ordinary gear and fittings appeared well adapted to the gun, which appeared in every way suitable for the armament of this class of boat.

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— No. 33. —

Her Majesty's Ship "Excellent, 14 May 1862.

REPORT on the Fracture of a Vent-piece of a 100-pounder Armstrong Gun.

During the ordinary practice from the 100-pounder Armstrong Gun, Register No. 71, after the seventh round the vent-piece was found to be badly fractured and rendered useless, there being an open irregular crack on the rear face, above and just touching the raised disc; it extended from one edge seven inches across the rear face and on the same edge from rear to front face.

This vent-piece has been kept exclusively for firing, and had fired 160 rounds.

— No. 34. —

Her Majesty's Ship "Excellent," 17 June 1862.

TRIAL of Captain *Coles'* Model of Shield for two 100-pounders—continued.

The object of this day's practice was to see how the guns and carriages worked when extreme elevation and depression were given, and also what effect heeling the ship had on the recoil of the gun.

For this purpose the "Hazard" was taken out and anchored off St. Helen's.

In every case the 14 lbs. charge, with solid shot, was used.

1st. With ship on an even keel. Three rounds were fired with the extreme elevation of 14°.

Rounds.	Gun Recoiled,	Run out again.	And had to be run out with Breast Tackle the remaining Distance of
	ft. in.	*ft. in.*	*ft. in.*
1	4 0	1 10	2 3
2	4 10	2 10	2 0
3	4 0	2 2	1 10

Everything appeared to work easily, but considerable force was required on the breast tackle to run the gun close out.

Gun came into a taut breech in each case; at the second round the carriage touched the buffers, and the breeching was then taken up nine inches on each end.

Two rounds were then fired horizontally.

Gun recoiled 4 feet 2 inches to a taut breech, and went close out.

Two rounds were then fired with the extreme depression of 4½°.

Gun recoiled 4 feet 5 inches to a taut breech, and went close out.

2d. With the ship having a weather heel of 4°.

One round was fired with extreme elevation making 18°, *i. e.*, 14° in addition to the heel of 4°.,

Gun came in 4 feet 10 inches to a taut breech, just touching the buffers; and went out 1 foot 10 inches; rather more difficulty experienced in running the gun close out than when ship was on an even keel.

One round was then fired with extreme depression, making only ½° depression, *i. e.*, 4½ less the heel of 4°.

Gun came in 4 feet 4 inches, and went close out all but 7 inches.

N. B. Total length that gun would recoil before striking the buffers was 4 feet 10 inches; but when extreme depression was used, this amount was reduced by 2 inches.

In every case the breeching appeared to have no undue strain, and everything worked smoothly; the difficulty in getting the gun out again after being fired with extreme elevation would be reduced if the notched plates for working the running-out levers, were made to extend farther up the inclines.

One of the depression chocks requires a slight alteration; when this is done, the extreme depression will be increased to the amount that the port allows, 6°.

The compressors were not used, nor were they required.

At the conclusion of the practice it was observed that the metal nut of the elevating screw had slightly sunk in the centre, owing doubtless to the enormous pressure which is brought on the screw when the gun is fired with extreme depression.

These screws are to be replaced by others of larger diameter and greater strength.

— No. 35. —

Her Majesty's Ship "Excellent," 20 June 1862.

Submarine Gun.

The "Storks" 110-pounder Armstrong gun having been placed on a platform made up of a gun slide with a few sleepers underneath, was loaded with a 14 lbs. charge and common shell, and laid for the butt 25 feet distant, measuring from muzzle.

The shell was filled with sand to bring it up to the weight of the solid shot, and the charge was enclosed in a pig's bladder.

When the tide had risen 6 feet above the axis, the gun was fired by means of Bickford's fuze. The explosion appeared to be very moderate, but when the tide had fallen, it was discovered that the shell had been broken by the charge, and three large fragments were picked up close to the butt; the fragments weighed respectively 22 lbs., 19 lbs., 9 lbs., which made up rather more than half the shell; one piece had struck the butt, but there was not the smallest possible indentation.

June 25. The same gun was fired with 14 lbs. charge and solid shot. Shot struck butt a little above point aimed at and lodged, the base of shot being just flush with its face, and the axis of shot making an angle of 20° with the line of fire. The butt was very much shaken, the planks in front and rear being started off.

Experiments with Submarine Gun continued.

July 4. A segment shell with 12 lbs. charge was fired from the 110-pounder, when the tide had risen to the same height above the gun, as in previous

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previous experiments, but on this occasion it was pointed to the right of the butt; the object being to find how far the shell would range in the water, 1° elevation was given, so that the shell might not strike the mud.

Shell rose about 12 feet from the muzzle, and ranged 100 yards before falling into the water.

Although the mud was carefully searched, no part of the shell was picked up. In its flight it appeared to rotate round its short axis.

July 9. This time a common shell with 12 lbs. charge was used, and the gun pointed for the butt.

Butt appeared to be shaken (though not very violently) by the shell, which, from the mark on the wood, must have struck nearly broadside on, and then fallen back, dropping into the mud point downwards; no lead remained on the projectile.

July 11. In order to give the projectile a greater initial velocity, in the following experiments the muzzle was covered with an old drum head and canvass well luted with white lead.

A shell was fired as in the last round, except that although empty it had a pillar fuze in it.

Shell struck butt two feet below point aimed at, cutting through a pile 13½ inches thick, and was picked up three feet from the opposite side. The action of pillar fuze for igniting the shell has not taken place.

July 15. Same as last round, but a live segment shell, fitted with a concussion fuze, was used. Shell either broke up in the gun, or on striking the water on leaving muzzle.

July 16. Solid shot, 14 lbs. charge. Shot struck six inches to left of point aimed at, 4 feet 6 inches below surface of water, and passed through butt, consisting of 13½ inch piles with five-inch oak plank bolted on in front. Shot could not be found, having probably sunk to a considerable depth in the soft mud.

July 17. Segment shell filled with powder, but without a fuze, was fired in a similar manner. Shell struck one foot below point aimed at, broke a plank, slightly indented a pile, and fell back.

COPIES from THIRD EXPERIMENT BOOK, commencing 4th September 1862.

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	1862:			
1	September 4 to 17	To ascertain penetration of Armstrong 110-pounder when fired under water. Continued from page 496, Second Experiment Book.	The shot penetrated both sides of "Griper;" shell burst in the vessel. The gun was placed with the muzzle 20 feet from the "Griper," and fired when covered with six feet of water.	452
2	September 12 -	Scraper for cleaning chamber of 110-pounder Armstrong gun.	The scraper merely took off the surface of the deposit, without materially assisting the projectile being run home.	454
3	October 8 - -	Moorsom and Elswick composition in Armstrong pillar fuzes.	The Moorsom composition was found to be as efficient as the Elswick on striking a ship, and superior in resisting explosion on striking the water.	454
4	October 7 - -	To ascertain penetration of 110-pounder when fired under water. Continued from September 17.	Four half-inch plates, bolted together, and 14 inches of wooden backing were penetrated by a flat-headed shot, fired with 14 lbs. charge. Distance as before, 20 feet.	456
5	October 27 - -	Trial of a new pattern rammer for 12-pounder Armstrong guns.	Found to be an improvement on the service pattern, but still requires modification.	4 6
6	November 10 -	To ascertain penetration of 110-pounders when fired under water. Continued from October 7.	Six half-inch plates bolted together, and the wooden backings, were penetrated by a common shot. Distance, 20 feet. Conoidal-headed shot found superior to flat-headed shot.	456
	1863:			
7	February 4 -	To ascertain whether shot which had become dented by exercise, &c., could be fired without the lead stripping.	Seven shot which had been used in exercise for several months were fired at the 2,600 yards target, with excellent results.	457
	1862:			
8	June 30 - -	On the comparative recoil of 40-pounder Armstrong and 8-inch guns.	40-pounder recoiled a little more than the 8-inch; but as its weight is only half that of the other, the strain on the breeching is less.	457
	1863:			
9	March 20 - -	Repair of an Armstrong gun, 110-pounder, which had become injured by a shell bursting in the bore.	Gun was put in a perfect state of repair with ship's resources, in 135 working hours.	457

— No. 1. —

Her Majesty's Ship "Excellent," 4 September 1862.

EXPERIMENTS with a view of ascertaining the penetration, &c., of Guns when fired under Water, continued.

THE hulk "Griper" was placed in a convenient position on the mud, and a 110-pounder, Register No. 53, was laid on a platform 20 feet from the ship's side, measuring from the muzzle.

The axis of the gun was laid horizontal, and directed for a spot under the ship's quarter, 14 feet from her stern-port, where the side fell in rapidly, making an angle from the vertical of 42°; the production of the axis made also an angle of 40° with the plane of the side.

The

The gun was loaded with a flat-headed projectile (110 lbs.) and a 14lbs. charge, and fired when the water had attained the height of six feet above the axis.

Result.—Struck the ship's side, about the spot on which the axis was directed. Penetrated the outer planking of 6-inch sound oak, cut through an 8-inch oak timber (sound), penetrated the inner lining of 4-inch fir (not sound), and struck a large oak rider, 18 inches square, into which it penetrated 2 inches.

Total penetration through sound wood, 21 inches.

Ship's side shaken to a considerable extent; round fracture, into which the water poured with great violence, and filled the ship immediately.

11 September 1862.

The gun being placed as before, 20 feet from the side of the "Griper," was loaded with a flat-headed solid projectile and 14 lbs. charge, laid for a spot about 12 feet before the stern-port and 5 feet above her keel. Where the side fell in, so as to make an angle of about 12° with the vertical, the axis of the gun was horizontal and nearly perpendicular to the plane of the side. The gun was fired when the water had attained the height of six feet above the axis.

Result.—Struck the ship's side about 12 inches to the right of the spot on which the axis was directed.

Penetrated both sides, cutting through two 8-inch timbers (sound oak) and 12 inches American oak planking (sound), making a total penetration through sound wood of 28 inches.

Ship's side greatly shattered for about 3 feet round the spot where the projectile penetrated the off side.

12 September 1862.

The gun being placed in a position as nearly similar as possible to that of the previous day's trial, was loaded with a 14 lbs. charge and the ordinary solid projectile, with the conoidal-shaped head, and laid for a spot about 6 feet abaft where the last shot penetrated, and where the position of the side, both with respect to the vertical and with respect to the axis, was similar to that where the last shot penetrated.

Result.—Struck the side very near the spot on which the axis was directed. Penetrated both sides, cutting through two oak timbers (sound), 12 inches of planking (American oak, sound), and the upper part of a knee (sound oak), 5 inches thick, making total penetration through sound wood of 33 inches.

Note.—When this round was fired, the vessel was full of water; consequently there was about 4·5 feet of water between the sides penetrated.

15 September 1862.

The gun being placed as before, 20 feet from the "Griper's" side, was loaded with a 14 lbs. charge and solid shot, with the conoidal-shaped head; the axis laid horizontal, and for a spot 13 feet before the stern port, where the side fell in, making an angle with the vertical of about 25°; the production of the axis made also an angle of 20° with the plane of the side.

The gun was fired when the water had attained a height of 6 feet above the axis.

Result.—Struck the ship's side about the spot on which the axis was directed. Penetrated the outer planking of 6-inch American oak (sound), cut through an 8-inch oak timber (sound), and the 4 inches of unsound fir planking, struck the upper end of an oak rider, 5 inches thick, which it broke, crossed the deck through 15 feet of water, struck the opposite sweep piece, which it broke, penetrating into it three inches.

Total penetration through sound wood, 22 inches.

16th September 1862.

The gun being placed at the same distance from the "Griper's" side as in the previous experiments, was loaded with a 12 lbs. charge and common shell (live), fitted with a pillar percussion fuze.

The axis laid horizontal and directed for a spot where the side fell in, making an angle with the vertical of about 30°; the production of the axis made also an angle of 20° with the plane of the side. The gun was fired when the water had attained a height of 6 feet above the axis.

Result.—Struck about the spot on which the axis was directed. Penetrated the side, and burst on passing through; entirely destroyed the side for the space of 5 × 3 feet, making an open fracture of 2 × 2·5 feet.

A large rider of 18-inch oak, in wake of shot, penetrated, broken in half, the portion struck blown to the opposite side of the ship. Several large fragments of shell found in the ship between decks.

17 September 1862.

The gun, being placed as in the previous experiments, was loaded with a 12 lbs. charge and common shell (live), fitted with a pillar percussion fuze.

The axis was laid horizontal, and directed for a spot where the side fell in, making an angle with the vertical of 25°; the production of the axis made also an angle of 28° with the plane of the side.

The gun was fired when the water had attained a height of six feet above the axis.

Result.—Struck about the spot on which the axis was directed. Penetrated the side and burst apparently on passing through. Destroyed the ship's side for the space of 4 feet by 3·5 inches, making an open fracture 3 by 2 feet.

The outer planking more or less started for many feet round fracture.

A large portion of the deck immediately above the fracture blown up, planks shivered, and beam broken.

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— No. 2. —

Her Majesty's Ship "Excellent," 12 September 1862.

Report of the Trial of a Scraper for the Chamber of the 110-pounder Armstrong Gun.

Received on board, on the 2d July, for trial and report, a scraper, proposed by Colonel Boxer, R.A., for the purpose of scraping the chamber of the 110-pounder, and thus obviating the inconvenience that occasionally arises from the projectile not gaining its original seat, owing to the accumulation of hard deposit in the chamber. The value of the instrument was tested in the following manner :—

1st. The 110-pounder, Register No. 71, was loaded with plugged shell and 12 lbs. charge; 12 rounds were fired, the rammer being marked and the comparative increase in the thickness of the deposit obtained by noting how far the projectile failed in gaining its original seat after each round. After the 12th round the scraper was used for five minutes as effectively as possible by two men who had been before instructed in its use.

Result.—A very small amount of the hard deposit appeared to come away, but the projectile did not succeed in gaining its seat more nearly than before.

2d. Two more rounds were then fired, and the scraper used as before, but with no better results.

3d. Three more rounds were then fired, and on the chamber being sponged out carefully with a wet sponge for about one minute, the projectile succeeded in gaining its original seat more nearly by about a quarter of an inch.

4th. Two more rounds were then fired, and the chamber damped with a wet sponge, and the scraper used as before.

Result.—The projectile succeeded in gaining the position it had obtained after the wet sponge alone had been used.

— No. 3. —

Her Majesty's Ship "Excellent," 8 October 1862.

In pursuance of an order from the Commander in Chief, dated 7th June, to the effect that Captain Hewlett should carry out experiments as soon as possible, with a view of ascertaining whether pillar fuzes prepared with the Moorsom composition would act as well as those prepared with the Elswick composition, on striking the side of a ship irregularly, after ricochet on water, the target ship, "Sultan," was towed out to Spithead, and anchored on the elbow of the Horse Shoal.

Armstrong 110-pounder and 40-pounder shell were then fired, under the circumstances and with the results mentioned hereafter.

The firing took place from Her Majesty's gun-boat "Foam," the gun being laid with P. B. sights, so that the shell should strike between 50 and 30 yards short of the "Sultan," the service charges and common shell, with full bursters, being used.

1. Fuzes prepared with the Moorsom composition shell, 110-pounder; distance of gun from target ship, 375 yards.

Results :

No. 1 Round.—*No burst.*—Struck the water 75 yards short, ricochetted over, the second graze being about 2,000 yards from the gun.

No. 2 Round.—*Burst.*—Struck the water 150 yards short, penetrated the ship's side after the first graze, and burst on lower deck.

No. 3 Round.—*Burst.*—Hit direct; entered a lower deck port, crossed the deck, and burst on striking the opposite side.

No. 4 Round.—*No Burst.*—Struck the water 100 yards short, ricochetted over, the second graze being about 3,000 yards from the gun.

No. 5 Round.—*Burst.*—Hit direct; burst on orlop deck.

No. 6 Round.—*No burst.*—Struck the water 80 yards short, ricochetted over, the second graze being 2,400 yards from the gun.

No. 7 Round.—*No burst.*—Struck the water 100 yards short, ricochetted over, the second graze being 3,000 yards from the gun.

No. 8 Round.—*Burst.*—Struck the water 100 yards short, penetrated the ship after the first graze, and burst on orlop deck.

No. 9 Round.—*No Burst.*—Passed through upper works; considered slight, but sound.

Note.—It was considered doubtful at the time whether this round struck the vessel at all, and more than doubtful afterwards, as no fracture in the upper works could be discovered.

The swell having increased, and the gun-boat rolling heavily, it was considered advisable to move her up to within 100 yards of the "Sultan."

No. 10 Round.—*Burst.*—Struck the water 30 yards short, penetrated the ship after first graze, and burst on main deck.

No. 11 Round.—*Burst.*—Struck the water 20 yards short, penetrated the ship after the first graze, and burst on lower deck.

No. 12 Round.—*Burst.*—Hit direct, and burst on lower deck.

No. 13 Round.—*Burst.*—Struck the water 30 yards short, penetrated the ship after the first graze, and burst on main deck.

No. 14 Round.—*Burst.*—Struck the water 12 yards short, penetrated the ship after the first graze, and burst on orlop deck.

No. 15 Round.—*Burst.*—Struck the water 30 yards short; penetrated the side after the first graze, and burst on main deck.

No. 16 Round.—*No Burst.*—Struck the water 50 yards short, ricochetted over, second graze 2,000 yards from the gun.

No. 17 Round.—*Burst.*—Hit direct, and burst on lower deck.

No. 18 Round.—*Burst.*—Hit direct, and burst on orlop deck.

No. 19 Round.—*Burst.*—Struck the water 5 yards short, penetrated the ship, and burst on orlop deck.

The following Rounds with 40-pounder Shell, were now fired.

No. 1 Round.—*Burst.*—Struck the water 10 yards short, penetrated the ship on first graze, and burst on orlop deck.

No. 2 Round.—*Burst* on first graze.

No. 3 Round.—*No Burst.*—Struck the water 10 yards short, entered the main deck port, crossed the deck, struck the opposite side, and fell on the deck.

No. 4 Round.—*Burst.*—Struck the water 5 yards short, penetrated the side after the first graze, and burst on orlop dock.

No. 5 Round.—*Burst.*—Struck the water 10 yards short, penetrated the ship after the first graze, and burst on lower deck.

No. 6 Round.—*Burst.*—Struck the water 12 yards short, penetrated the ship after the first graze, and burst on orlop deck.

No. 7 Round.—*Burst.*—Struck the water 15 yards short, penetrated the ship after first graze, and burst on lower deck.

No. 8 Round.—*Burst.*—Struck the water 10 yards short, penetrated the ship after the first graze, and burst on lower deck.

No. 9 Round.—*Burst.*—Struck the water 15 yards short, penetrated the side, and burst on lower deck.

No. 10 Round.—*Burst.*—Struck the water 20 yards short, penetrated the side, and burst on main deck.

Second Pillar Fuze prepared with the Elswick Composition.

Shell 110-pounder.—Distance of gun from "Sultan," 375 yards.

No. 1 Round.—*Burst.*—Hit direct, and burst on lower deck.

No. 2 Round.—*Burst* on first graze.

No. 3 Round.—*Burst.*—Struck the water 10 yards short, penetrated the side after the first graze, and burst on orlop deck.

No. 4 Round.—*Burst.*—Struck the water 50 yards short, penetrated the side after the first graze, and burst on lower deck.

No. 5 Round.—*Burst* on first graze.

No. 6 Round.—*No Burst.*—Struck the water 200 yards short, ricochetted over.

No 7 Round.—*No Burst.*—Struck the water 200 yards short, ricochetted over.

No. 8 Round.—*Burst* on first graze.

The gunboat was now moved up to 100 yards from the "Sultan."

No. 9 Round.—*No Burst.*—Struck the water 10 yards short, ricochetted over.

No. 10 Round.—*Burst*, on first graze.

No. 11 Round.—*Burst.*—Struck the water 30 yards short, penetrated the side after the first graze, and burst on lower deck.

TABLE showing the RESULTS of the EXPERIMENT.

FUZE.	Hit en Ricochet and Burst.	Hit Direct and Burst.	Ricochetted over.	Burst on First Graze.	Hit en Ricochet and no Burst.	Doubtful.	Total Rounds Fired.
Pillar Fuze: Moorsom Composition, 110-pounder	8	5	5	-	-	1	19
Pillar Fuze: Elswick Composition, 110-pounder	3	1	3	4	-	-	11
Pillar Fuze: Moorsom Composition, 40-pounder	8	-	-	1	1	-	10

NOTE.—With a view of correctly comparing the action of fuzes, prepared with different compositions, they were fired alternately, although in the foregoing Report, for the sake of convenience, they are classed according to the nature of the composition.

N.B.—On examining the gun after the experiment it was ascertained, from some injury caused to the grooves, that at least one shell had burst in the gun; it was considered that No. 2 round of the 110-pounder, prepared with the Elswick composition, was the shell that had done so.

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— No. 4. —

Her Majesty's Ship "Excellent," 7 October 1862.

EXPERIMENTS to ascertain the penetration, &c., of Guns, when fired under Water, continued.

WITH a view of still further carrying out these experiments, a target 4 feet square, composed of four ½-inch boiler plates bolted together (making a total thickness of 2 inches), was secured to the side of the "Griper," nearly amid-ships, where the side fell in considerably, making an angle with the vertical of three degrees.

The gun (110-pounder) was placed 20 feet from the target, measuring from the muzzle, laid horizontal, with its axis pointed exactly for the centre of the target, loaded with a flat-headed solid projectile, and 14 lbs. charge, and fired when the water had attained a height of 6 feet above the axis.

Result.—Struck the target about three inches to the right of the spot on which the axis was directed. Penetrated the plate and 14 inches of backing, lodged in shelf piece, immediately in the rear of target. Shelf piece much shattered and ship's side, round fracture, greatly shaken.

Fracture in plate, a clean circular hole 8 inches in diameter, two small cracks radiating from the fracture.

— No. 5. —

Her Majesty's Ship "Excellent," 27 October 1862.

REPORT of the Trial of a New Pattern Rammer for the 12-pounder Armstrong Gun.

RECEIVED on board for trial and report on the 24th June, two rammers for the 12-pounder Armstrong guns, constructed after the pattern proposed by Major Milman, R.A.

The head of these rammers differ from those of the ordinary service ones, in the absence of the second swell.

Remarks.—These rammers have been in constant use for four months, one having been attached to the field battery, and the other to the 12-pounder on board, where it has been used both for exercise and practice, the latter being of nearly daily occurrence.

Result, &c.—They have been found to answer moderately well the purpose for which they are intended, and are considered as an improvement on the service pattern; some slight difficulty however, has been experienced (on a few occasions when the chamber has been foul) in getting the projectile well home into its seat, owing to the absence of the requisite weight in the head; it was consequently judged that if the cylindrical portion of the head was increased in length to 12 inches, retaining the gradual slope off of the head to the staff (this making the head very similar to that of the short rammer, supplied with the 9-pounder lately received on board), the requisite weight would be obtained, and thus the instrument would be rendered more efficient.

— No. 6. —

Her Majesty's Ship "Excellent," 10 November 1862.

EXPERIMENTS to ascertain the penetration, &c., of Guns when fired under Water, continued.

WITH a view of still further carrying out these experiments, a target 8 feet × 4 feet, composed of six half-inch boiler plates bolted together, making a total thickness of three inches, was secured to the side of the "Griper," nearly amid-ships, where the angle of the side from the vertical was about 3°.

No. 1 Round.—The gun (110-pounder) was placed as in the previous experiments, 20 feet from the target, measuring from the muzzle, laid horizontal, with its axis directed for the centre line of the target, about 12 inches from the right hand edge, loaded with a solid wrought-iron flat-headed projectile, 14 lbs. charge, and fired when the water had attained a height of 6 feet above the axis.

Result.—Struck the target about the spot on which the axis was directed, broke in the two outer half-inch plates, making a round fracture 7 inches in diameter, drove the remaining plates back into the wood 2½ inches, but without breaking them; projectile fell back; shelf piece in wake of blow (sound) broken severely; lining shattered for a considerable extent.

Note.—Outer planking, timbers, shelf-piece, moderately sound; inner plankings not sound.

12 November 1862.

No. 2 Round.—The gun (110-pounder) being placed as during the previous experiments, 20 feet from target, was loaded with a solid cast-iron projectile (conoidal head), and 14 lbs. charge, laid for a spot about 18 inches to the left of fracture caused by previous experiment, and fired when the water had attained a height of six feet above the axis.

Result.—Struck the target about eight inches to the right of the spot on which the axis was directed, or 10 inches from former fracture.

Shot broke up, and fell back.

Broke all the plates, driving the fragment into the side to the depth of 12 inches, making an irregular fracture in the target 14 × 10 inches; right-hand edge of plate started from the side 2½ inches.

Shelf-piece in wake of blow broken, and lining shattered to a considerable extent.

14 November 1862.

No. 3 Round.—The gun being placed as during the previous experiments, was loaded with a solid cast-iron projectile (conoidal head) and 14 lbs. charge, laid for a spot, about 20 inches to the left of fracture caused by previous experiment, and fired

fired when the water had attained a height of six feet above the axis.

Result.—Struck the target about the spot on which the axis was directed. Broke in all the plates, driving the fragments through the side into the ship, making an irregular fracture in the target, 12 × 9 inches. Shelf-piece broken, and ship's side destroyed for a considerable extent.

— No. 7. —

4 February 1863.

Questions having arisen as to whether Armstrong shot became so much injured by knocking about the decks as to render them useless, the exercising shot of the 40-pounder guns, seven in number, were trimmed off by a hammer and chisel, sufficiently to enable them to be put into the gun.

In some cases, they had become so much injured, that it was necessary to strip off about two inches of the lead, measuring from the base of the shot.

Result.—The shot fell close to the target fired at (2,600 yards), and although carefully watched, none of the lead appeared to have come off.

The same day, two 12-pounder shot, which had been exposed to the weather since October 1861, had their leaden coating stripped off. It was found that the shot were in as good order as when received.

— No. 8. —

On the Comparative Recoil of the 40-pounder and 8-inch Guns.

In the half-yearly report of the "Marlborough," dated 30 June 1862, it is stated that the recoil of the Armstrong 40-pounder is excessive, even with rear trucks off; and in a letter, dated 12th November 1862, it is proposed by Captain Stewart, that these guns should have 9-inch, instead of 8-inch brackings. It was therefore considered advisable to try the comparative recoil of 40-pounder and 8-inch guns, at 2° elevation, with breechings and tackles unrove, and with all trucks off.

First.—40-pounder, 5 lbs. charge shot:—

	ft.	in.	Mea. ft.	in.
At the 1st round, the gun recoiled	9	3	8	9
„ 2d „ „	8	3		

Second.—8-inch 10 lbs. charge shot:—

	ft.	in.	ft.	in.
At the 1st round, the gun recoiled	7	6	7	4½
„ 2d „ „	7	3		

Third.—8-inch 5 lbs. charge double shot:—

	ft.	in.	ft.	in.
At the 1st round, the gun recoiled	5	8	5	7
„ 2d „ „	5	6		

And as double shot may, under exceptional cases, be fired with full charges,—

Fourth.—8-inch 8 lbs. charge, double shot.

At the first round the gun recoiled	10 ft. 3 ins.	9 ft. 10½ ins.
At the second ditto	9 „ 6 „	

It, therefore, appears that the recoil of the 40-pounder is a little greater than that of the 8-inch gun with distant charge; but as its weight is only half (33 cwt. as against 65 cwt.), the stress on the breeching cannot be sufficient to require an increase in thickness.

It may here be stated that 1,000 rounds have been fired from a 40-pounder on board the "Excellent," allowing only four feet recoil, and using the same breeching, without a strand or even a yarn breaking.

The hitches certainly do render up, and when the usual seizing is passed, they jam; but one racking turn has been found sufficient to prevent this occurring.

— No. 9. —

Her Majesty's Ship "Excellent," 20 March 1863.

The 110-pounder Armstrong gun belonging to the "Foam," used in the experiment for testing the comparative value of the Elswick and Moorsom's composition in the pillar fuzes, having been injured by a shell bursting in the bore, it was considered desirable to try whether it could be put into perfect order by the artificers, and with the resources of the ship.

1. In order to see what effect the roughening of the lands and grooves had on the projectiles, six rounds were fired at the 2,600 yard target, when the shot fell as accurately as usual; and, on re-examining the bore, there was no perceptible difference in the appearance of the flaws. The machine for cleaning out the rifling was made of two blocks of wood, fitted to take the grooves, and pressed apart by a strong steel spring, the files for reducing the irregularities were made from old broken files, and were let into the surface of the block. The springs for pressing them out into the grooves being adapted from old revolver springs, which had become unserviceable. The staff for pushing in and pulling out the machine was kept in line with the axis by a guide fixed in the muzzle, and one groove was cleaned out at a time.

The time taken in completing the work was as follows:—

1 carpenter - - 60 hours.
1 blacksmith - - 18 „

whose work was carried on simultaneously; after which—

1 armourer - - 75 hours.

Total time in effecting the repair, 135 working hours.

Everything was made with the ship's resources, except the steel spring (value 1 s.) for pressing out the halves of the block.

After completing the work, six more rounds were fired at the 2,600 yard target, the practice being very good.

Appendix, No. 29.

App. No. 29. COPY of REPORT on the Present Condition of the WHITWORTH BATTERY at *Shorncliffe*.

REPORT of Examination of 12-pounder Whitworth Rifled Brass Guns, belonging to "H" Battery 9th Brigade Royal Artillery, at Shorncliffe Camp.—17th March 1863.

No. 128—14 cwt. 3 qrs. 10 lbs. Received 17/2/62; passed as experimental, and not proved.

Examination at Shorncliffe Camp, after firing 200 rounds:

Bore expanded from 49 in. from muzzle to end of bore, and deeply dented at seat of shot on bearing side of rifling from 49·5 in. to 57·3 in.

Greatest amount of expansion:

Minor diameter at 56 in. = ·06
Major ditto at 57 in. = ·045

Flaws in bore at 48·3 "left" ·55 long, ·4 wide and ·1 deep, and metal rough from 49 to 53 inches all round.

No. 129—14 cwt. 3 qrs. 14 lbs. Received 17/2/62; passed as experimental, and not proved.

Examination at Shorncliffe Camp, after firing 200 rounds:

Bore expanded from 49·5 in. from muzzle to end of bore, and deeply dented at seat of shot on bearing side of rifling from 46·3 in. to 57·5 in.

Greatest amount of expansion:

Minor diameter at 56 in. = ·14
Major ditto at 54·5 in. = ·107

Flaws in bore at 51·8 "left" 1 inch long, ·35 wide and ·1 deep, and at 52·55 in. "left" ·7 long, ·2 wide and ·15 deep, and metal rough from 48·5 to 54·5 inches all round.

No. 131—11 cwt. 2 qrs. 16 lbs. Received 26/3/62; proved 22/4/62 with two rounds of 3 lbs. and one shot 12 lbs.

Examination after proof.

Bore expanded from 47 to 55 inches, the expansion being ·03 at the largest part.

Examination at Shorncliffe Camp, after firing 200 rounds:

Bore expanded from 46 in. from muzzle to end of bore, and deeply dented at seat of shot on bearing side of rifling from 46·5 to 57 inches.

Greatest amount of expansion:

Minor diameter at 56·5 in. = ·1
Major ditto at 57 in. = ·087

Flaws in bore at 54·3 in. "left" 1 inch long, ·4 wide and ·25 deep from 42·3 to 44·3 "R. of up," ·7 wide and ·1 deep, and from 44·8 to 46·8 "R" about ·05 deep and metal rough from 49 to 56 in. all round.

No. 132—11 cwt. 3 qrs. Received 26/3/62; proved 22/4/62 with two rounds of 3 lbs. and one shot 12 lbs.

Examination after proof.

Bore expanded at proof from 49 to 54 in., the expansion being ·033 at largest part.

Examination at Shorncliffe Camp, after firing 200 rounds:

Bore expanded from 48 in. from muzzle to end of bore, and deeply dented at seat of shot on bearing side of rifling from 46·3 to 56·8 in.

Greatest amount of expansion:

Minor diameter at 55 in. = ·1
Major ditto at 58 in. = ·084

Flaws in bore at 52·3 in. "left" 1·25 in. long, ·25 wide and ·2 deep, at 45·3 "R." 1 in. long, ·3 wide and ·05 deep, and 46·3 "L. of up" 1·3 long ·4 wide and ·2 deep, and metal rough from 49·3 to 55·3 in. all round.

(signed) *H. F. Strange*, Colonel,
Inspector of Artillery.

War Office,
29 April 1863.

Alex. T. Tulloh, Major General,
Director of Ordnance.

Appendix, No. 30.

App. No. 30. COPY of Mr. WHITWORTH's Letter of the 15th May 1861, in which he requests that two coiled barrels for 70-pounder Guns may be supplied to him from *Woolwich*.

(7662—18.)

Sir, Fenton's Hotel, 15 May 1861.

I BEG to acknowledge receipt of your letter of May 13th. It appears to me that some misapprehension exists as to the nature of the request made by my firm.

I am desirous of trying my principle of rifling with large guns made on the coiled system. This has not yet been done. The Whitworth guns lately tried at Woolwich were all made with inner tubes of homogeneous iron. I was supplied from Woolwich with outer hoops of coiled iron for two guns; to these I wish to apply two coiled tubes (inner), without which the application of my system of rifling to the coiled guns cannot be fairly tested.

With this object, I should be obliged, if I could be supplied with two coiled inner tubes, not two complete guns, from the Royal Arsenal.

I have, &c.
(signed) *Joseph Whitworth.*

The Under Secretary of State,
War Office, Pall Mall.

Appendix, No. 31.

PAPER delivered in by *John Anderson*, Esq., 30 April 1863.

STATEMENT of Mr. *Baker* and Mr. *Sandeman*.

App. No. 31.

On Wednesday, 15th April, Mr. Hulse waited upon Mr. Anderson to read a statement which he had drawn up relative to the circumstances of the 7-inch gun constructed for Mr. Whitworth in the Royal Gun Factories.

The first step was to compare, date by date, the whole of the correspondence, and to read the letters, so as to be sure that the copies of both parties were correct. This was done, and all found to be correct, and we agreed as to the correspondence.

Mr. Hulse then began to read a paper which he said was Mr. Whitworth's statement in answer to an attack made upon his personal honour by the Ordnance Select Committee, and that their report was in print, and in the hands of the Members of the House of Commons. The first part of the paper appeared to be a history of the conferences, drawings, and correspondence previously to the gun being approved of by Mr. Whitworth, which was correct, but when Mr. Hulse came to the explanation of our letter of 19th December, exception was taken to the way in which he had construed the meaning of that letter; and what he appeared to convey during the conversation which then took place was, that the construction of the gun on our plan had been conceded by Mr. Whitworth entirely upon the grounds that this gun could not be made in any other way by the appliances at that time in the department. After a lengthy discussion upon this point, he then said, We will pass on to the other portion of the paper, and revert to this letter again, at the same time both parties making a pencil-mark against their respective papers that it might not be overlooked.

During the reading of the remainder of the paper, Mr. Hulse frequently paused, and asked Mr. Anderson if he saw any reason to object to what had been read. In a general way, Mr. Anderson answered, that so far it appeared correct, and occasionally appealed to us to state our opinions. To the greater portion of it we did agree; but we expressed our minds fully upon the construction that Mr. Hulse had given to the word "detail," as applied to the structure of the gun; and we decidedly contended, with Mr. Hulse, that the two guns bore no similarity in their system of construction; and that it was not to suit the convenience of the department only, that the system of construction was changed, but that Mr. Anderson had given his experience to produce only the very best gun so far as he was capable.

Mr. Anderson concurred in the opinions we expressed; and certainly did not agree to this part of Mr. Hulse's paper.

We instanced to Mr. Hulse, amongst others, the case of the large gun which had been recently made for Mr. Thomas; and upon these grounds, we claimed the construction of these guns, although made to a bore and weight, and rifled as desired by Mr. Whitworth or Mr. Thomas.

Previously to the completion of the reading of the paper, many exceptions having been made during the conversation, and certain modifications having been suggested, Mr. Hulse, of his own accord, said, "I will take this paper away, and re-write it in such a way that I think there will be no difference of opinion between us." Mr. Anderson fully concurred in this, and said that when he received the paper, he would read it carefully over with us, and if there were any objections to make, he would put them on paper, so as clearly to define our views of this matter; and Mr. Hulse was reminded, at the same time, not to lose sight of the exception which we had taken to the manner in which he had construed the letter of the 19th, and also one dated the 31st December, both of which were marked on the paper held in the hand of Mr. Baker.

He then left us, as well as Mr. Anderson, with the distinct understanding that he would re-write the paper, and submit it for a further perusal.

The paper did not pass out of Mr. Hulse's hand during the interview, nor was it read entirely through.

The statement in print does not appear to us similar throughout to that read by Mr. Hulse; it contains, however, two of the points to which we decidedly objected in Mr. Hulse's paper. (See page 15.)

(signed) *J. Baker*,
Principal Clerk,
R. G. Factories.
29 April 1863.

Wm. Sandeman,
Chief Draughtsman,
R. G. Factories.

Appendix, No. 32.

PAPER delivered in by *William Wilson Hulse*, Esq., 30 April 1863.

App. No. 32.

MEMORANDNM for STATEMENT as to 7-inch GUN DRAWINGS.

On 7 December 1861,

SIR G. C. LEWIS, by a letter signed B. Hawes, informed Mr. Whitworth that he sanctioned the manufacture at Woolwich of a 7-inch gun, to be made "according to your (Mr. M.'s) principles, and under your directions."

11 December.

Mr. Whitworth came up to London, December 11, put himself in communication with the Director of Ordnance, and also conferred with Mr. Anderson with reference to the manufacture of the 7-inch gun at Woolwich.

A drawing of the gun, showing the dimensions and outlines proposed by Mr. W., the mode of distributing the metal, and the details of construction recommended, was then sent by Mr. W. to Mr. A. at Woolwich. It was, however, understood that the details of construction were to be such as Mr. Anderson considered most advisable, Mr. W. being satisfied to leave the details to Mr. A., when the dimensions, weight, and distribution of the metal had been determined on. That these, as proposed by Mr. W., differed materially from those adopted previously for the 7-inch guns made on Sir W. Armstrong's plan, will be evident when it is considered that Mr. W. proposed to make his 7-inch gun to weigh 7½ tons, while the Armstrong 7-inch gun, as previously made at Woolwich, only weighed 4 tons.

19 December 1861.

Mr. A. wrote to Mr. W. acknowledging the receipt of Mr. W.'s drawing, and sending two drawings, W—68, W—69, "showing a gun finished according to *the outlines of your (Mr. W.'s) drawing*, but constructed according to a simple arrangement of the coils, and one which I would recommend for your consideration," &c. Mr. W. did give Mr. A's drawings his consideration, and as the outlines and dimensions he had settled were not materially departed from, he looked upon them as modifications of his plan, embodying, as was expected, Mr. Anderson's suggestions as to details of construction. *While Mr. W. fully appreciated the value of Mr. A.'s suggestions, he considered* that his drawings, W—68, W—69, were in some respects objectionable; the distribution of the metal, he thought, might be better provided by adhering more closely to his original drawing. Mr. W. thought that the construction to be adopted would be best settled by a personal conference with Mr. A.; and, as his health at that time was not good, it was arranged that his partner, Mr. Hulse, should go to Woolwich, and explain to Mr. A. Mr. W.'s views as to his proposed modifications.

21 December.

Mr. W.'s firm wrote to Mr. A., acknowledging receipt of W—68, W—69, and informing him that Mr. Hulse "will see you (Mr. A.) about them on Monday."

Mr. Hulse did go to Woolwich; he there fully discussed the question of the drawings of the 7-inch gun, and explained Mr. W.'s and his own views, and settled, in conference with Mr. Anderson, that plan that was to be carried out. As the gun was to be made at Woolwich, the preparation of the drawing of the gun, as so settled, was left to Mr. Anderson.

24 December.

Mr. A. wrote to the W. O. C., saying, Mr. A., with reference to his promise "to Mr. Hulse, begs to forward a tracing, W—82, showing an amended build of muzzle-loading gun."

26 December.

The W. O. C. wrote, acknowledging receipt of the tracing, W—82, saying "we will avail ourselves of your offer to undertake the responsibility, and to leave the details of construction entirely to yourself (Mr. A.)," concluding, however, with suggestions of certain alterations proposed.

31 December.

Mr. Anderson wrote to W. O. C., "with reference to your letter of December 26, I enclose a tracing, W—87, showing the 7-inch muzzle-loading gun, slightly altered in the exterior diameter at the breech."

This drawing being the plan of construction finally settled, was considered by Mr. W. to be the best plan which, under the circumstances of the gun being made at Woolwich, could be adopted. It was a modification of the first drawings sent by Mr. Anderson, and stated by him to be "finished to the outlines of Mr. W.'s own drawing," and it provided for the amount of metal (7½ tons) being employed, which Mr. W. had proposed, an amount which he considered necessary to enable as large a charge of powder to be used as the gun could consume. In this respect the gun proposed by Mr. W., and made at Woolwich, differed essentially from the 7-inch gun made on Sir W. Armstrong's plan, which only weighs 4 tons and fires 14 lbs. of powder, while the bore could consume efficiently double that quantity of powder. Mr. W.'s gun, as finally settled, had of course the bore and rifling turn first proposed by him, the changes in details of construction, principally suggested by Mr. Anderson

Anderson (who best knew what was adapted to the Woolwich system of manufacture), had been discussed with Mr. Hulse, and settled in conference, and were eventually submitted to Mr. Whitworth, and approved by him, when he signed the drawing finally settled. But as this drawing showed a gun which, in the inside, and on the outside, and in the distribution of the metal, differed in no material respect from the drawing originally supplied by Mr. Whitworth, and as the changes in detail had, from time to time, been considered by him, Mr. W. considered that he was making a correct assertion when he stated in his letter to the "Times," "That his 7-inch gun was made according to drawings supplied by himself." The Members of the O. S. C., who, under these circumstances, have thought fit to charge Mr. W. with making assertions that are the "reverse of truth," would, with equal justice, charge every engineer with falsehood who would call a drawing his own which had, in fact, been made by his draughtsman, and embodied any suggestion of detail not made by himself. Every practical engineer will admit that it is quite usual to give general instructions to carry out an intended plan, leaving details to be filled in; and that even, in such a case, he who gave the general instructions would be entitled to consider as his the drawings which carried out his instructions, though the details were supplied by some one else. App. No. 32.

Appendix, No. 33.

LETTER from Mr. *Anderson* to the Right Honourable *William Monsell*, M. P., dated 4 May 1863. App. No. 33.

Royal Gun Factories, Royal Arsenal, Woolwich, S.E.,
4 May 1863.

Sir,

WITH reference to my Evidence before the Committee on Ordnance on 30th April, and to your question respecting the specification to govern the supply of the 12-pounder L. S. guns made in the Royal Gun Factories, I have the honour to state, that I have caused most careful search to be made, but that I am quite unable to trace any specification of that nature in the records of this office.

I have, &c.
(signed) *John Anderson*,
Assistant Superintendent.

Right Honourable W. Monsell, M. P.,
&c. &c. &c.

Appendix, No. 34.

PAPERS delivered in by Captain *H. W. Gordon*, C. B., 4 May 1863.

(In reply to Question 1013).

App. No. 34. SUMS paid for Guns, Shells, and Fuzes, complained of by the Artillery Committee.

DESCRIPTION of ARTICLE.	Number made.	COST. £.	s.	d.
Ordnance, Armstrong 12-pounder Land Service - -	438	45,093	15	6
Shells, Segment, 12-pounder „ - -	255,163	60,050	15	6
Fuzes, Armstrong { Concussion „ - -	229,607	22,992	11	2
O.P. { Time „ - -	164,734	22,886	14	6
Total Cost - - - £.		151,023	16	8
Deduct value at 70·444, and such shell assumed to be serviceable - - - - - - - - -		10,860	2	2
Reduced Cost - - - £.		140,163	14	6

H. W. Gordon, P. S. S.

(In reply to Question 1026).

RETURN of old pattern Fuzes issued up to this Date:

Concussion - - - - - - - - -	217,458
Time - - - - - - - - - -	162,431

H. W. Gordon, P. S. S.

(In reply to Query 1031).

RETURN of Time Fuzes issued since November 1862 from Woolwich:

Fuzes, Time, O.P. - - - - - - - -	1,633

H. W. Gordon, P. S. S.

(In reply to Query 1036).

RETURN of 12-pounder Armstrong Land Service Guns made at Elswick, and in the Royal Gun Factories:

In the Royal Gun Factories - - - - - - -	362
At Elswick - - - - - - - - - -	76
TOTAL - - -	438

Royal Arsenal Woolwich,
28 April 1863.

H. W. Gordon, P. S. S.

(In reply to Query 1037).

RETURN of 12-pounder Armstrong Segment Shells, issued up to above Date:

Shells, Segment, 12-pounder Armstrong - - - -	175,532

H. W. Gordon, P. S. S.

Appendix, No. 35.

COPIES of REPORTS received respecting the ARMSTRONG GUN in *Canada* and *New Zealand*. App. No. 35.

Auckland, New Zealand,
Sir, 7 January 1862.

I HAVE the honour to forward a detailed description of Maori rifle trenches, as given me on the spot before I opened fire on the position of "Te Arei" with the Armstrong guns, &c.; also some information which I have been able to obtain since concerning the action of artillery in New Zealand warfare.

On arriving at No. 7 Redoubt, and finding no stockade to breach, to enable the troops to take the position of "Te Arei" by assault, for a broad open roadway led over the crest of the hill into the centre of the Maori position, we were struck with the extraordinary occurrence of finding ourselves in front of the enemy with apparently nothing for artillery to fire at, and remarking the same, were told that if the white flag was hauled down, the rifle trenches of "Te Arei," as well as those on the neighbouring hills, would be alive with Natives, as far as their fire was concerned; but they themselves would be all but invisible. Attentively considering their lines of rifle trenches along the crests of the hills all around, coupled with their peculiar mode of warfare, and also being informed that their trenches were generally constructed in the following ingenious manner—first, a narrow, deep trench is made, then on the side fronting their assailants it is dug out in the form of a shoe, the earth so excavated being thrown outside on the top to the rear, rough wood-work, beams, &c., so arranged as to support the earth above the excavation, then forming a secure place, where they immediately retire after delivering their fire—it appeared to me that I had before me in these rifle trenches a target of about eight feet in height, counting from the top of the trench to the bottom of the excavation, and running laterally some distance; and I calculated that aiming about the centre of this target, some three or four feet below the earth thrown on the top rear of the trench, the shell penetrating just below the crest of it, and meeting with the resistance of the rough wooden support of the earth in the trench, or any other body, momentarily to arrest the flight of the shell, it would burst inside, and deal destruction around. To increase my chance of unearthing some of these wily Natives, I procured plants for the gun-wheels, and trails to rest upon, so as to adjust the gun to the greatest nicety of level. The shells were observed from the battery to enter just below the crest of the trench, carrying destruction to any Maories, in that position of the pits. Viewing it, however, as a whole, it is not exactly the target that an artillery officer would choose, to demonstrate the destructive effects of the Armstrong guns; but considering the peculiar circumstances attending the warfare in front of the position of "Te Arei," it was the best and only way to use this gun to advantage; and from observation, I am fully convinced of the decided superiority of rifled ordnance over smooth-bored: at the same time, there can be little doubt but that the shrewd cunning of these artful Natives, in dispersing in twos and threes, and never fighting except they are concealed amidst the abounding cover of their country, neutralises to a certain extent the effect of the destructive powers of any artillery that may be brought against them. Notwithstanding, these Maories recommenced hostilities in right good earnest on Friday morning, March 15th; they suddenly ceased on the following Monday, March 18th, and, 24 hours afterwards, decamped on their way back to Waikato Country. One is also struck with the remarkable fact that since the war at Taranaki not a stick has been cut in Waikato, nor have any preparations for defence been made in support of the King movement, which would appear to demonstrate that they had felt the power of artillery; and, indeed, they say they will build no more pahs for artillery to knock down, but will take to the bush, &c.

Being very anxious to get at the real facts of the case with respect to the effect of the guns, and to ascertain what the Natives themselves thought of the artillery fire, I made enquiries in all directions, and was informed by a gentleman, who has been for the last 29 years in New Zealand, and who has great knowledge of both the Natives and their country, and who has also visited the Waikato District since the termination of hostilities at Taranaki, that the Maories had a great dread of artillery. They told him they could not come out in the open, because they could not face the fire of the guns; and that had no artillery been brought against them they would have constructed strong "pahs," and any attempt of the troops to take them without artillery would, they said, be attended with similar results as the attack by Colonel Despard, in the north, in 1845. Also, that the night-firing of the guns and mortars, &c., as well as the Artillery fire in general, created great alarm amongst them, until they, at last, exclaimed that the very woods were not safe; they also stated that the fire of the Artillery was exceedingly accurate, the shell ploughing up their trenches, and they could not endure the harassing uncertainty of shells dropping amongst them during all hours of the day and night; winding up, by saying, that they would excuse themselves for killing unarmed men, &c., whenever they could pounce on them; for "ambushes," they said, were only "Big Guns," or "Artillery," and that they would take to the bush and rifle-pits, and spread themselves all over the country, and do all the damage they could.

It appears to me that they fully understood the secret of their strength, which lies in this very dispersion, combined with never fighting, except

App. No. 35.

except where the nature of their magnificent country, consisting of mountains, ravines, gullies, with high fern, bush and forest, favours their peculiar mode of warfare.

I have, &c.
(signed) *H. Mercer,*
Captain Commanding Royal Artillery.

(True copy.) *Edw. Bingham,* D.A.G.

EXTRACTS from Letter dated Auckland, New Zealand, 5 February 1863; addressed to the Deputy Adjutant-General Royal Artillery.

EXPERIMENTAL practice commenced at various ranges according as the nature of the ground would allow against the sections of the two sorts of pahs, tree and rail, usually constructed by the Natives for the purposes of defence; they were of the toughest wood and strongly bound with flax, &c. The effect of the Armstrong shot and shell, and the breaching, in a very short time was very satisfactory, and showed the power of the guns. I may remark, that, combined with the vertical fire of 8-inch mortars, to search out and destroy the rifle pits immediately behind the stockade, the strongest pah ever built would quickly be rendered untenable; as long as these descriptions of ordnance are in the Colony there will be no more pahs or fortified positions made by the Natives.

The number of splinters, when firing with shell, could not be counted with any accuracy, many passing through the irregularly open rails &c., so that only the general effect on the stockade was noticed after each round. It was found that the shell with the concussion fuse only was the most destructive and effectual in bringing down the stockade, acting as a solid shot on the first line of trees or rails, and then bursting between the lines of defence, and tearing away the 2d line of trees or rails. It was also noticed that this 2d line was brought down before the first line gave way; the tenacity with which the rails bound with the flax and transverse rails and beams, bound also with flax across, hung together, proved the great strength of this sort of stockade; in fact the whole face of it had literally to be smashed away by salvoes before a proper practicable breach could be made. The firing by salvoes was found to be very effective, much more so than when the guns were fired singly. In firing the salvoes, some of the tubes were blown, opportunity was then taken of registering in detail the effect of the shot or shell thus fired singly afterwards.

(signed) *H. Mercer,* Capt. R.A.

(True extract.) *Ewd. Bingham,* D.A.G.

EXTRACT from Letter dated 6 April 1861, Hawrange, New Zealand; addressed to the Deputy Adjutant-General Royal Artillery.

THERE can be no doubt of the superiority of the Armstrong gun over smooth-bored ordnance. The gun has done, and always will do a great deal more than any other description of gun in the service, throwing the shell with greater precision, &c.

(signed) *H. Mercer,*
Captain Commanding Royal Artillery.

(True extract.) *Edw. Bingham,* D.A.G.

EXTRACTS from Reports upon the Armstrong Guns and Sights of Batteries of Field Artillery in Canada.

D Battery, 4th Brigade R.A., at Montreal.

Report dated 25 March 1863.

Gun No. 9.—The whole of the coils in the powder chamber appear to be separating. The lines of separation can be seen, and felt with the finger. They are about $1\frac{1}{16}$ apart.

Breech Screw.—Five inches broken off end of thread.

Vent Pieces.—One slightly split round the centre.

Gun No. 12.—There is a slight fault in the grooves about 19 right of up.

Breech Screw.—Two inches broken off end of thread.

Gun No. 59.—This gun is also beginning to separate in the coils in the powder-chamber, but not so much as No. 9.

Breech Screw.—Two-and-a-quarter inches off end of thread.

Vent Pieces.—Two a little split in centre.

Gun No. 94.—Breech Screw: Three inches off end of thread.

Vent Pieces.—One cracked round the centre.

Gun No. 108.—Breech Screw: Two-and-a-quarter inches off end of thread.

Vent Pieces.—One a little cracked in centre.

Gun No. 128.—A very slight appearance of separation in one of the coils of the powder-chamber "left of up." Two flaws "right of up," one four feet two, and the other four feet eight from the breech. The first is about one-eighth deep, the second a little more.

Breech Screw. — Two-and-a-half inches of thread broken off.

Vent Pieces.—One a little cracked.

E Battery, 4th Brigade R.A., at Toronto, C.W.

Report dated 15 March 1863.

On the voyage from England the guns were exposed to damp, both from the escape of surplus steam from the engines, and from salt water. The exterior surface was covered with rust, the removal of which took off the browning. The interior being covered with white lead, did not suffer at all. The guns are perfectly serviceable, and in good order, with the exception of requiring browning.

F Battery, 4th Brigade R.A., at London, C.W.

Report dated 21 March 1863.

There is a slight chip off the surface of the bore close to the muzzle of one of the guns. As there has been no practice with them, I am unable to ascertain whether the accuracy of the piece is unimpaired, but I am of opinion that it is not.

G Battery, 4th Brigade, R.A., at Hamilton.

Report dated 28 March 1863.

The guns and sights have been entirely free from any casualty during the past winter.

H Battery

H Battery, 4th Brigade R.A., at Montreal.

Report dated 18 March 1863.

No defect has been noticed in the guns or sights, with the exception of that caused by the practice, or the slight flaws in the bores of the guns, which appear to have increased on an average depth of ·05 inch to ·06 inch; but this difference being so minute, cannot be certainly affirmed.

(True extracts.) *Edw. Bingham*, D.A.G.

Halifax, N.S.,
Sir, 1 May 1862.

One of the guns of the battery under my command (12-pounder Armstrong, No. 328, R.G.F.) was injured on passage from England as follows:—from a blow received on the muzzle, the scarf of this coil gave way to the extent of about three inches round, and about half an inch into the length of the gun. Whilst at drill, this portion became entirely detached, and I gave orders for the gun to be shortened one-eighth of an inch at the rifling, and about one-fourth of an inch at the outer edge. This has just been done by the battery armourer-serjeant very satisfactorily.

The coils could not have been properly welded together when the gun left the arsenal.

I have, &c.,
(signed) *W. Morris*, Capt. R.A.
Commanding A. Battery, 8th Brigade.

(True copy.) *Ewd. Bingham*, D.A.G.

The Officer Commanding 8th Brigade,
Royal Artillery, Dublin.

Auckland, New Zealand,
Sir, 5 February 1863.

I have the honour to forward photographs of the disabled gun-carriages,* and also of the sections of the tree and rail pahs, executed by Assistant Surgeon W. Temple, M.B., Royal Artillery, during the practice. The information, given by Dr. Temple, with each photograph, showing the circumstances under which it was taken, is from the battery records of the Armstrong guns. Experimental practice was commenced with the tables given by Colonel Lefroy, R.A., in the occasional papers of the Royal Artillery Institution; but, however, gradually rising to the tables in possession of the battery, and obtained from Shoeburyness. Wooden targets, 9 by 9, were at first used, after which experimental practice commenced at various ranges, according as the nature of the ground would allow, against the sections of the two sorts of pahs (tree and rail), usually constructed by the Natives for purposes of defence. They were of the toughest wood, and strongly bound† with flax, &c.; the effect of the Armstrong shot and shell and the breaching, in a very short time was very satisfactory, and showed the power of the gun. I may remark, that, combined with the vertical fire of 8-inch mortars to search out and destroy the rifle pits immediately behind the stockade, the strongest pah ever built would quickly be rendered untenable; as long as these descriptions of ordnance are in the colony there will be no more pahs or fortified positions made by the Natives.

The word "pah," in red ink, in the column of remarks, denotes that the section of the pah was struck, but wide of the linen target. These linen targets were torn to shreds, and were replaced from time to time; the number of splinters, when firing with shell, could not be counted with any accuracy, many passing through the irregularly open rails, &c., so that only the general effect on the stockade was noticed after each round. It was found that the shell with the concussion fuze only was the most destructive and effectual in bringing down the stockade—acting as a solid shot on the first line of trees or rails, and then bursting between the lines of defence and tearing away the second line of trees or rails. It was also noticed that this second line was brought down before the first line gave way, the tenacity with which the rails bound with the flax, and transverse rails and beams, bound also with flax across, hung together, proved the great strength of this sort of stockade; in fact, the whole face of it had literally to be smashed away by salvoes before a proper practicable breach could be made. The firing of salvoes was found to be very effective, much more so than when the guns were fired singly. In firing the salvoes, some of the tubes were blown, opportunity was then taken of registering in detail the effect of the shot or shell thus fired singly afterwards. Linen targets (obsolete infantry pattern) were sewn together and nailed against the stockade, the gunners were directed to breach below the lower edge of the black line, running through the bull's eye; this experimental practice was carried on in the first day's breaching with the linen target as a sort of guide, after which no linen targets were used. No. 4 photograph shows the effect of the first afternoon's breaching, the portions of the stockade left standing were strengthened and renewed, and another afternoon's breaching under and witnessed by Lieut.-General Cameron, C.B., commanding the forces in New Zealand, took place, with what result No. 5 photograph demonstrates. &c.

I have,
(signed) *H. Mercer*,
Captain, R.A.

Colonel C. Bingham,
Deputy Adjutant General, &c.,
Royal Artillery.

---

* Report forwarded to England by the last mail.
(signed) *H. M.* Capt.

† After each day's practice at the pah, the damaged portion was renewed with new rails and also bound afresh with new flax. (signed) *H. M.* Capt.

War Office,
5 May 1863.

Alex. T. Tulloh,
Director of Ordnance.

Appendix, No. 36.

App. No. 36.

COPY of LETTER to Sir *W. Armstrong*, 4 November 1859, appointing him Superintendent of the Royal Gun Factory, and defining his Duties.

Sir, War Office, 4 November 1859.

IN consequence of the great importance of providing with the utmost expedition, and in greater numbers than has been hitherto contemplated, rifle guns, both of wrought and cast iron; and considering, also, that cast-iron guns can be obtained of excellent quality, and in any numbers from the trade, I have come to the conclusion that the casting of guns in the Royal Gun Factory may be advantageously given up; and that the buildings now occupied by the Royal Gun Factory, together with the machinery, may, in addition to the buildings now devoted to the manufacture of guns upon the method introduced by you, be applied to the same purpose, and to the rifling of guns in general.

In thus uniting the two factories, it has appeared to me that it will be most convenient to the public service to place the new establishment under your superintendence, with the title of Superintendent of the Royal Gun Factory for Rifled Ordnance; and I am to acquaint you, that Mr. Anderson will be appointed your Assistant Superintendent.

Colonel Eardley Wilmot has already been informed of this arrangement, and will be repared to hand over to your charge, the whole of the existing establishment at your arliest convenience.

I have, &c.
(signed) *S. Herbert.*

Sir W. Armstrong,
&c. &c. &c.

Appendix, No. 37.

App. No. 37.

STATEMENT showing the Amount and Rates paid for certain GUNS to the ELSWICK ORDNANCE COMPANY, compared with the original Rates assumed in Sir W. G. Armstrong's Letters, Nos. 4 and 5, printed in the Appendix to the Report from the Select Committee on Ordnance, page 252.

DESCRIPTION.	Numbers.	Actual Rates Paid.	TOTAL.	Rates assumed in the Letters above quoted.	TOTAL.	Difference.
		£.	£.	£.	£.	£.
110 Pounders - - -	209	700	146,300	1,200	310,800	132,000
„ „ - - -	50	650	32,500			
40 Pounders - - -	219	328	71,832	600	342,000	171,933
„ „ - - -	301	285	85,785			
„ „ - - -	50	249	12,450			
25 Pounders - - -	1	230	230	400	12,400	5,570
„ „ - - -	30	220	6,600			
12 Pounders - - -	69	170	11,730	250	22,500	7,767
„ „ - - -	21	143	3,003			
	950	£.	370,430	£.	687,700	317,270

Memo.—In order that the above result may not convey an erroneous impression, it should be understood that the prices assumed by Sir William Armstrong, in 1858, were for 200 guns only, and were, as stated by him, merely approximate.

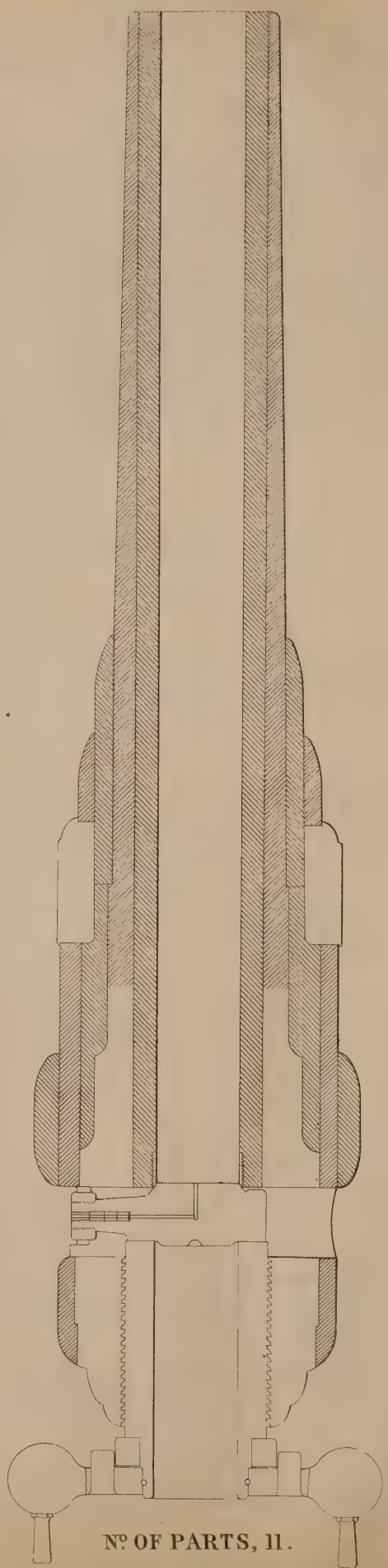
War Office,
5 May 1863.

H. W. S. Whiffin,
Assistant Accountant General.

W. 15
808.

SIR W. ARMSTRONG'S 110 Pr BREECH LOADING GUN.

Scale 1 inch to a foot.



No. OF PARTS, 11.

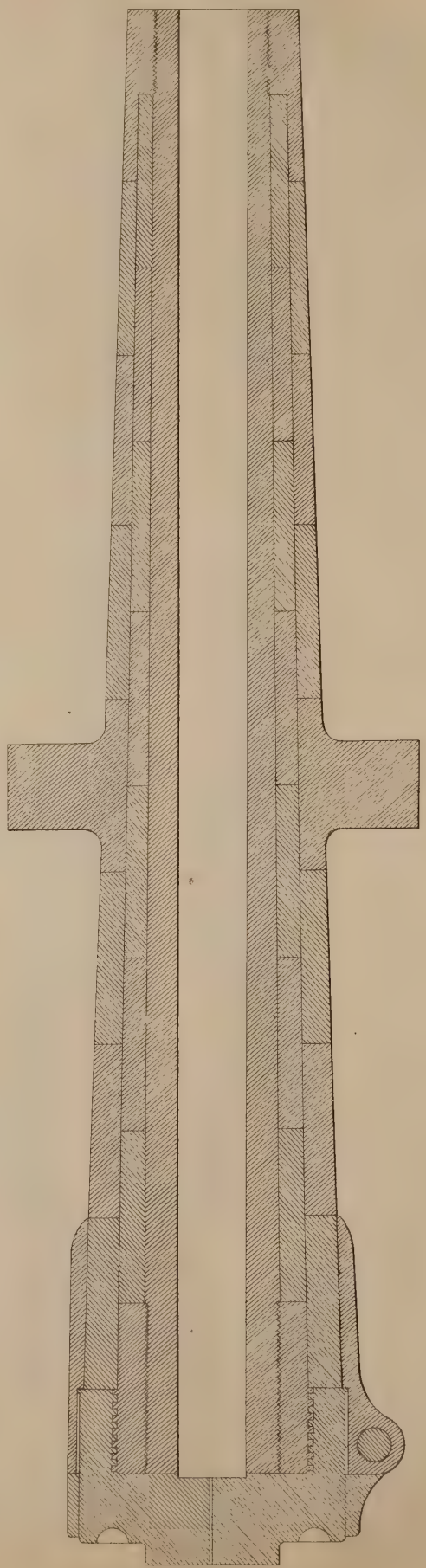
No 487. Ordered, by the House of Commons, to be printed, 23 July 1863

W. 14
807.

Mr. WHITWORTH'S BREECH LOADING GUN.

Diameter of Bore 5.5 inches.

Scale 1 inch to a foot.



No. OF PARTS, 19.

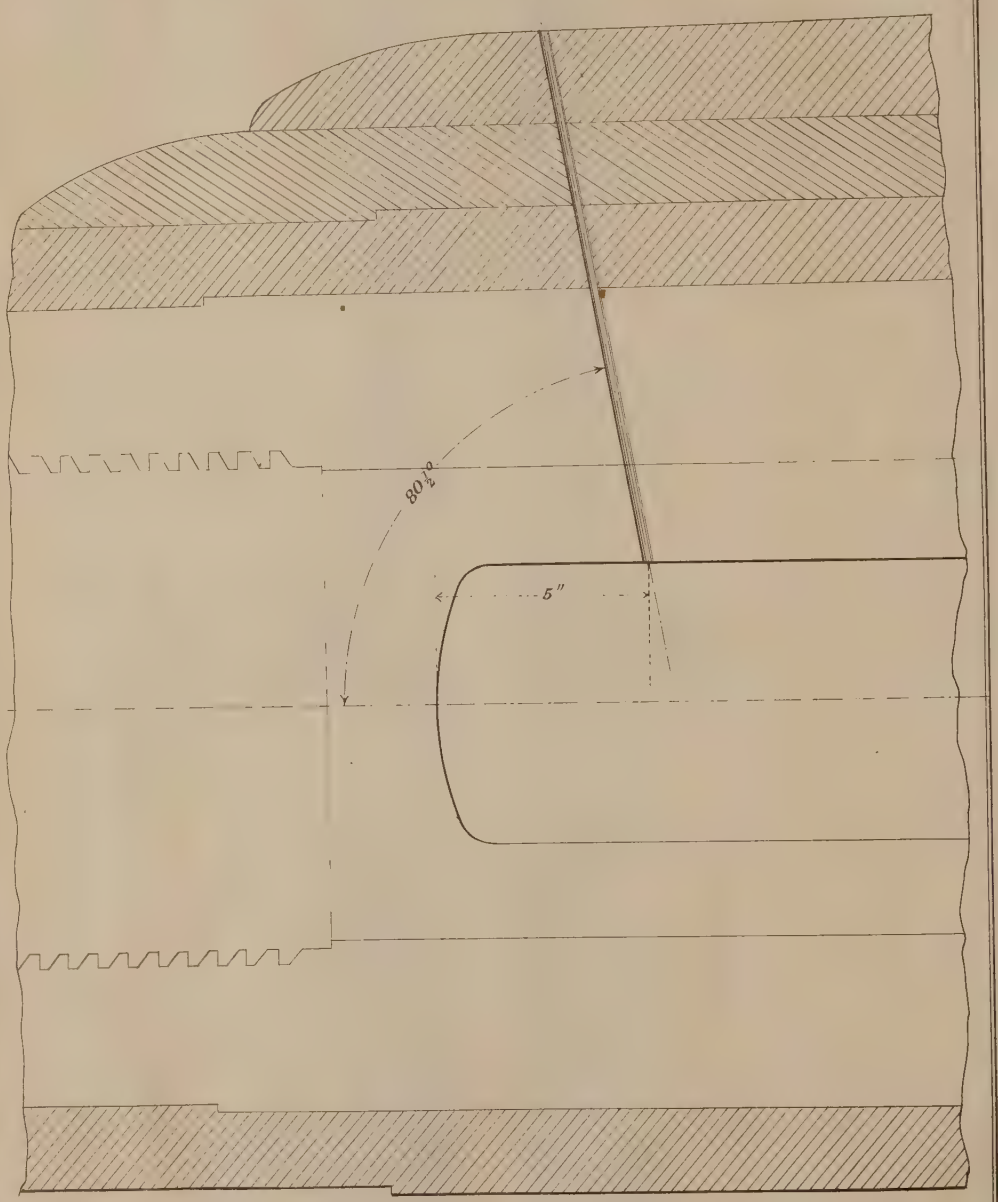
No. 487.. Ordered, by the House of Commons, to be printed, 23 July 1863

ROYAL GUN FACTORIES.

W. 13
802.

Mr. WHITWORTH'S M. L. GUN (6·4″ BORE.)

Shewing proposed position and angle of Vent Hole.

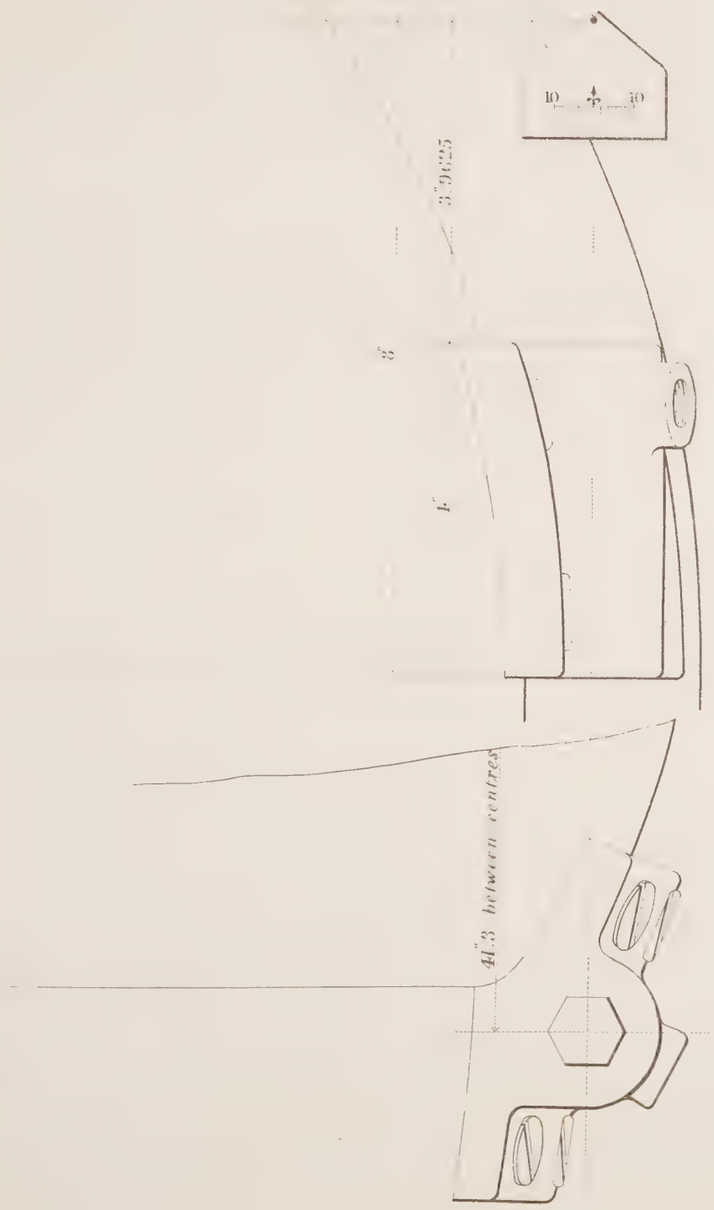


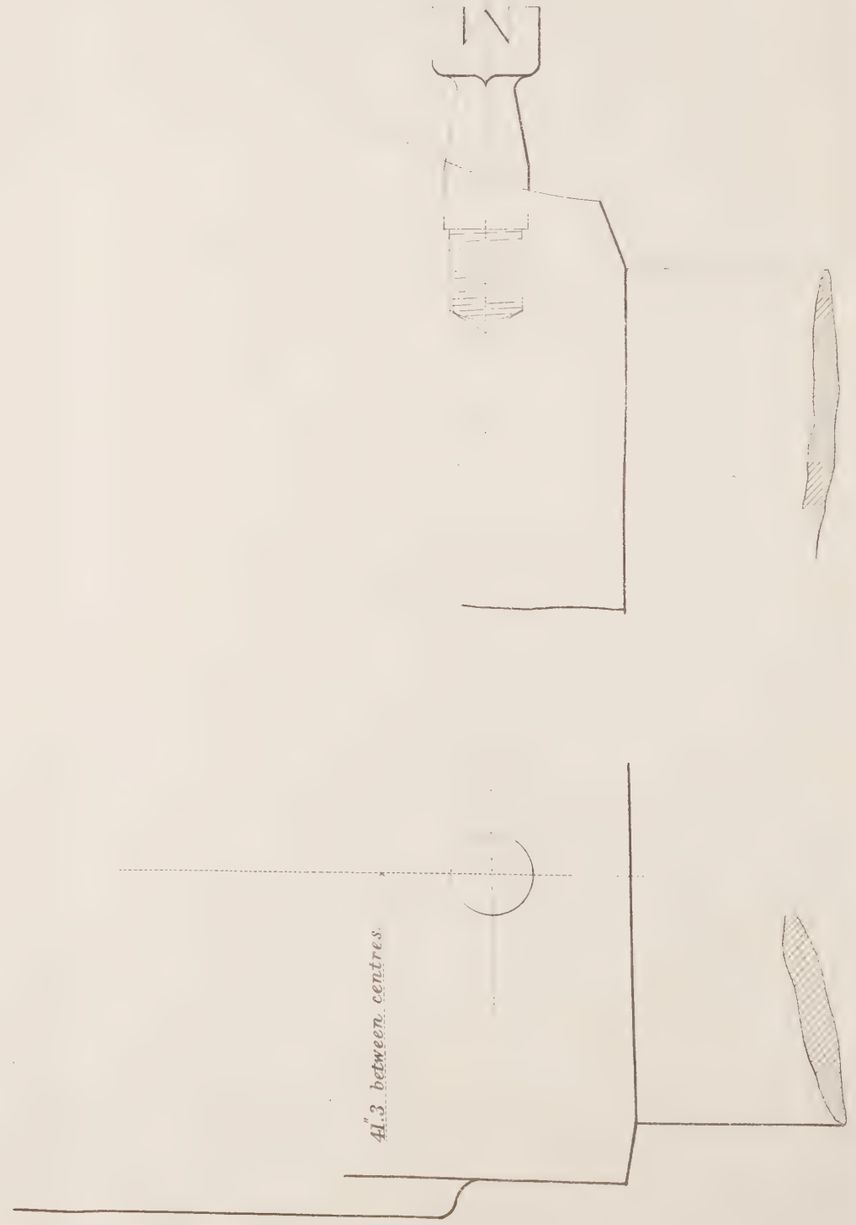
No 487. Ordered, by the House of Commons, to be printed, 23 July 1863
Henry Hansard, Printer.

ROYAL GUN FACTORIES

W.
800.

PROPOSED METHOD OF SIGHTING Mr WHITWORTH'S 6.4" M.L.GUN.



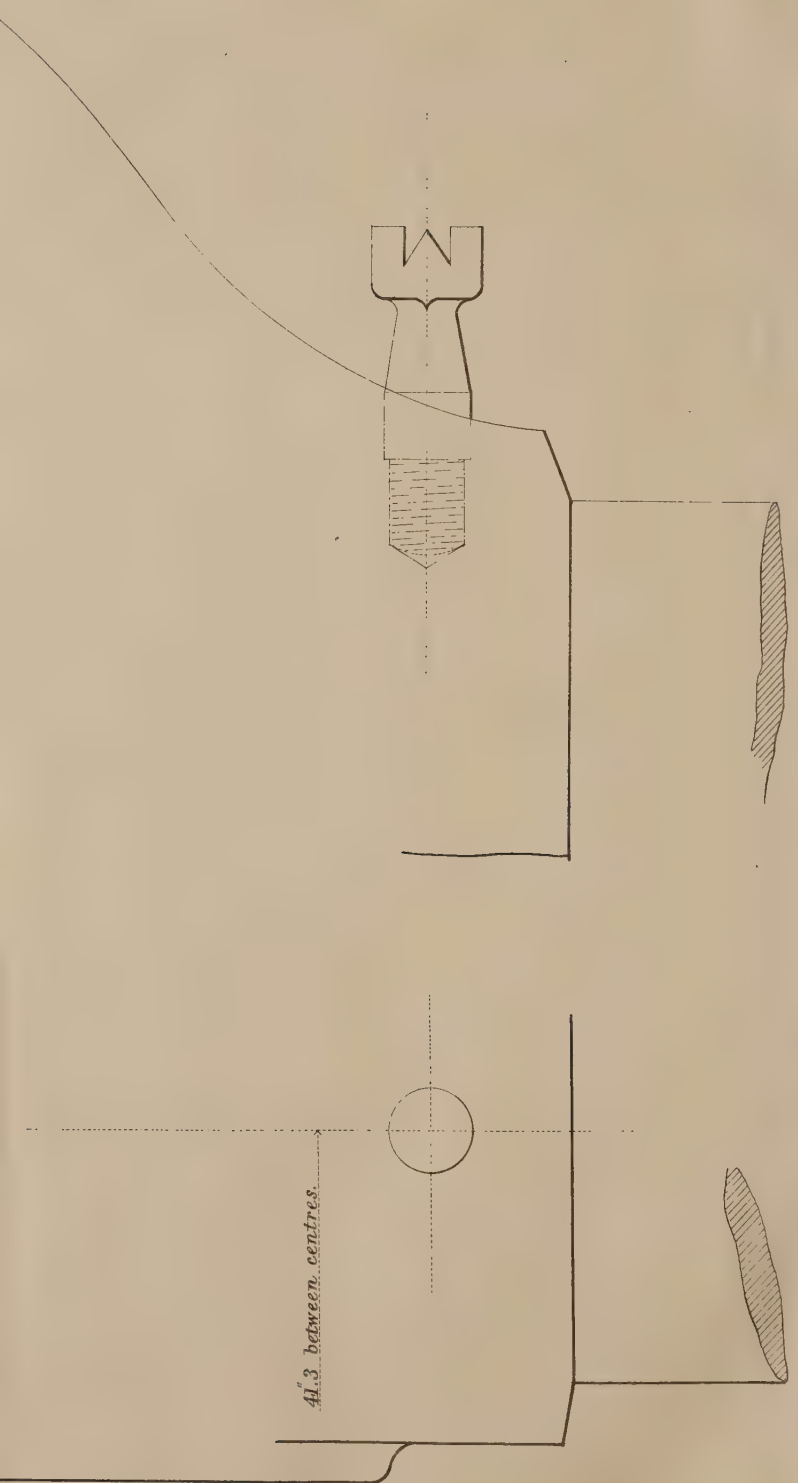


Nº 487. Ordered, by the House of Commons, to be printed, 23 July 1863

Henry Hansard, Printer

W.
800.

M.L.GUN.



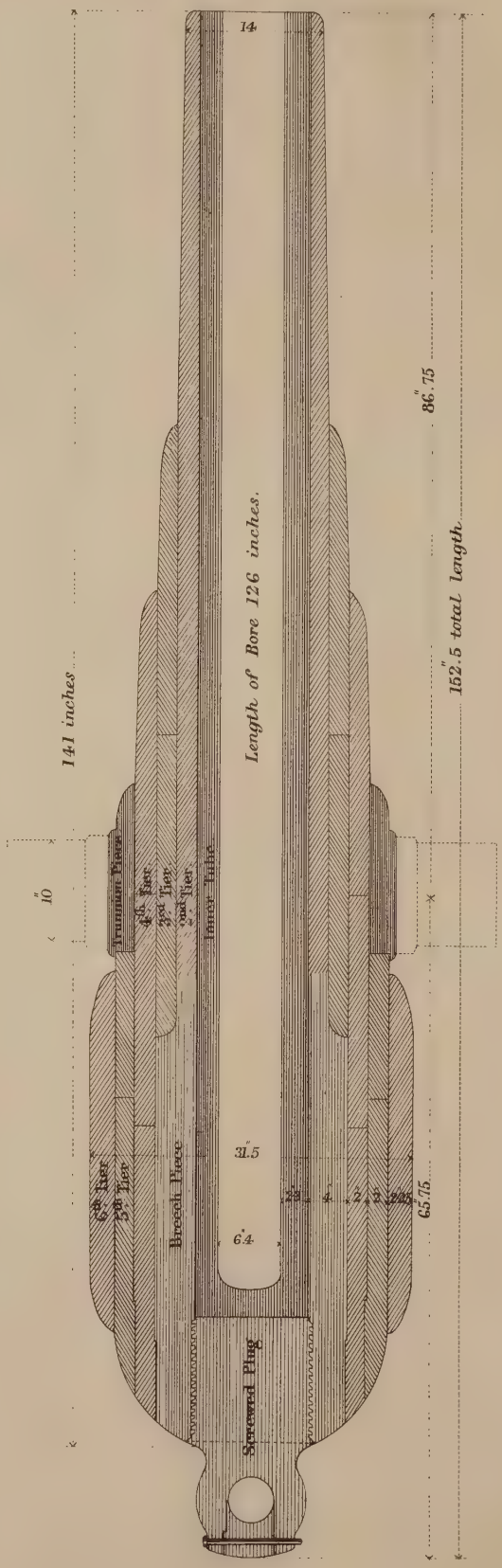
7. Ordered, by the House of Commons, to be printed, 23 July 1863

Henry Hansard, Printer.

W. 799. 10

Mr WHITWORTH'S 7 INCH M.L.GUN AS MADE IN THE R.G. FACTORIES.

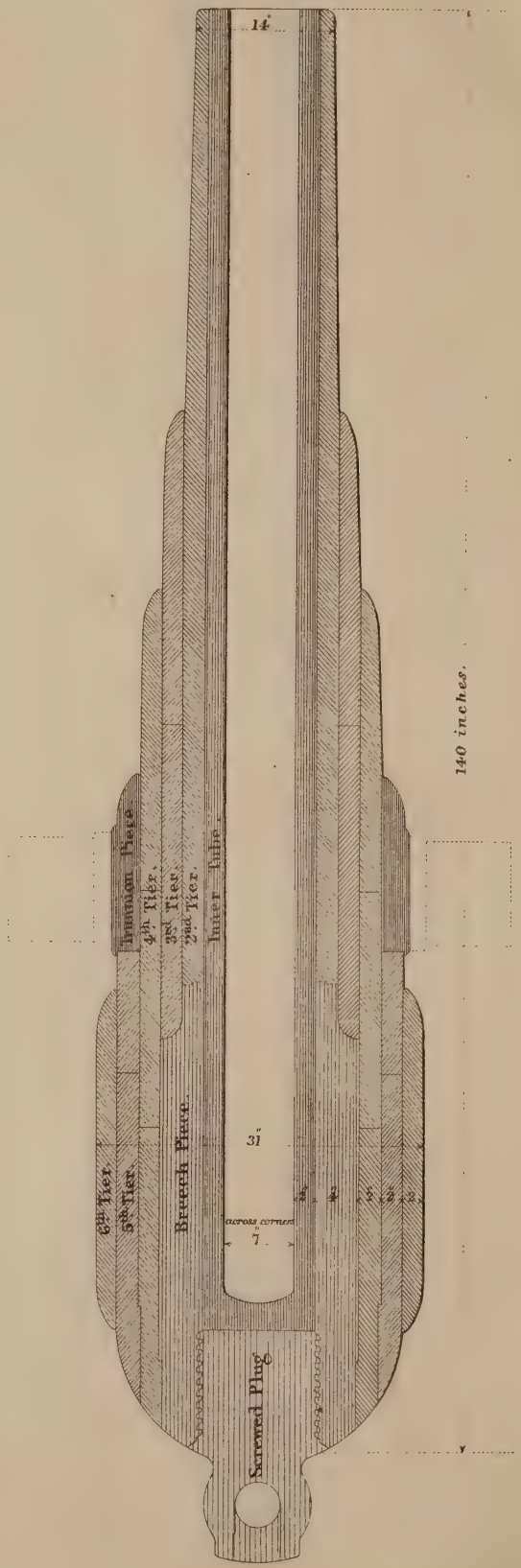
Scale $\frac{3}{4}$ of an inch to a foot.



John Anderson.

No 487. Ordered, by the House of Commons, to be printed, 23 July 1863

Scale ½ of an inch to a foot.

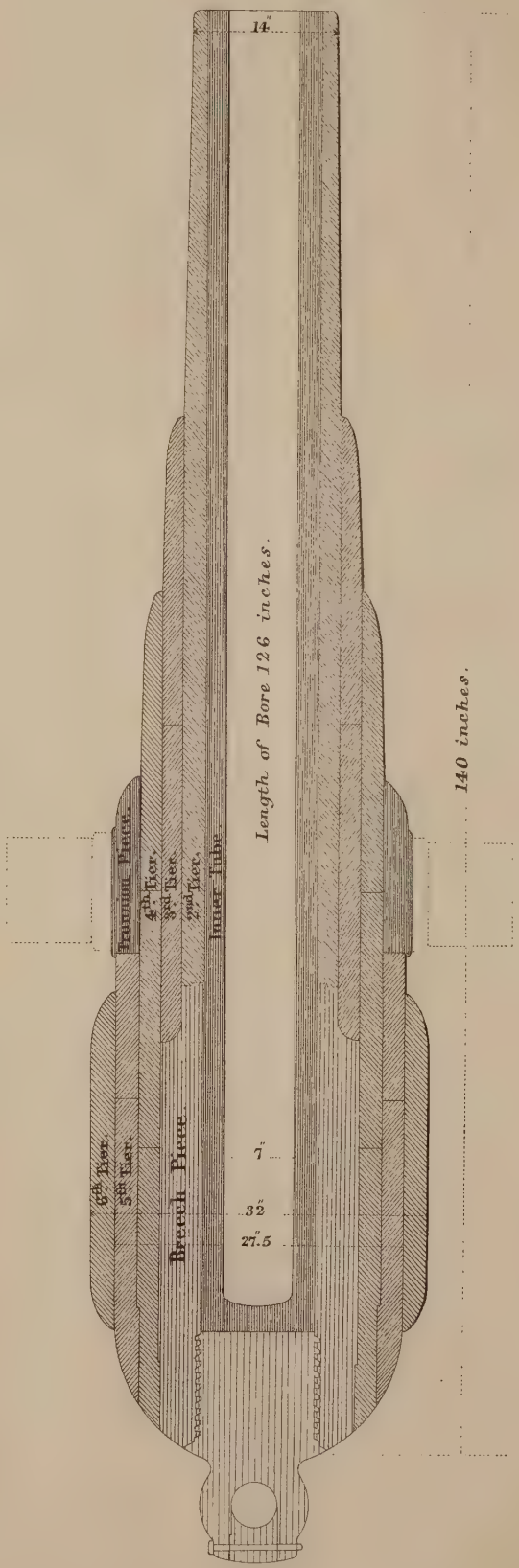


12 PARTS.

N°487. Ordered, by the House of Commons, to be printed, 23 July 1863

W. 797. 8

Scale $\frac{3}{4}$ of an inch to a foot.

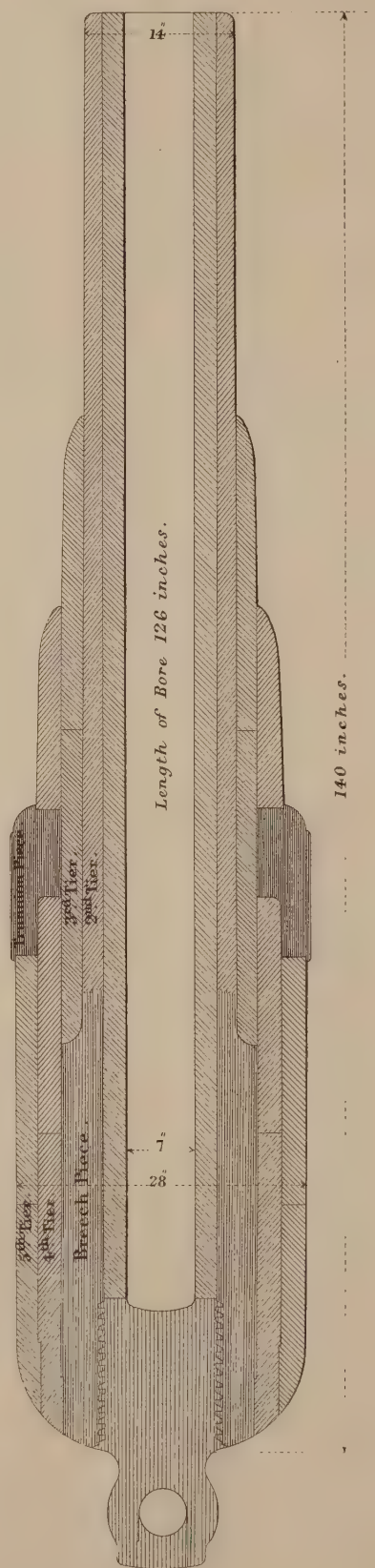


12 PARTS.

N°487. Ordered, by the House of Commons, to be printed, 23 July 1863

W. 796. 7

Scale $\frac{3}{4}$ of an inch to a foot.

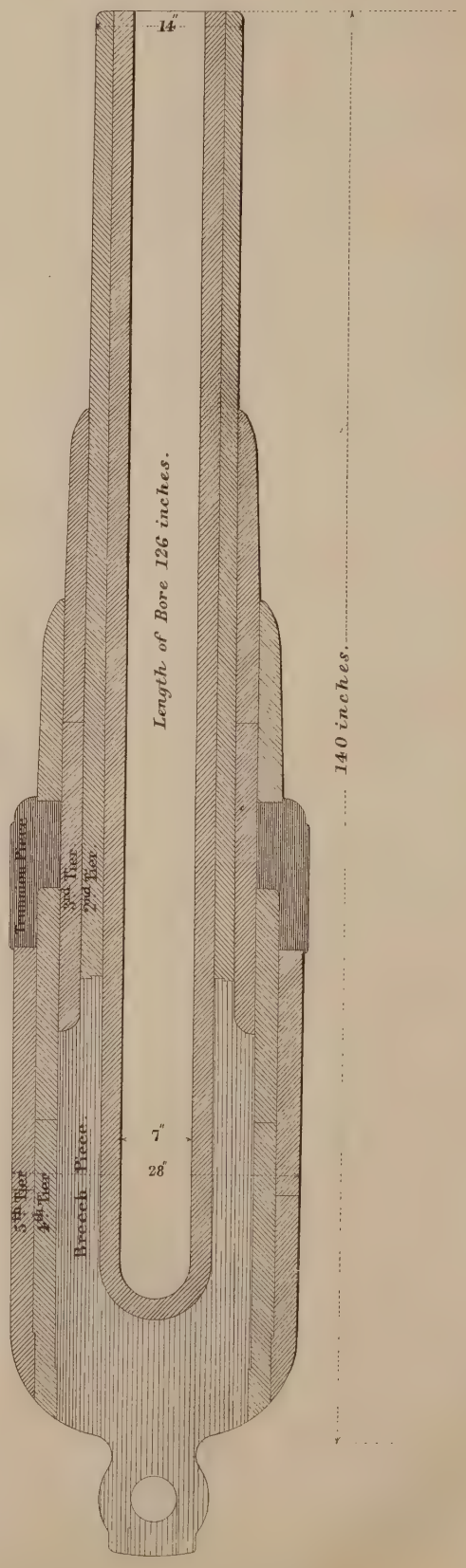


11 PARTS.

N° 487. Ordered, by the House of Commons, to be printed, 23 July 1863

Henry Hansard, Printer.

Scale $\frac{3}{4}$ of an inch to a foot.

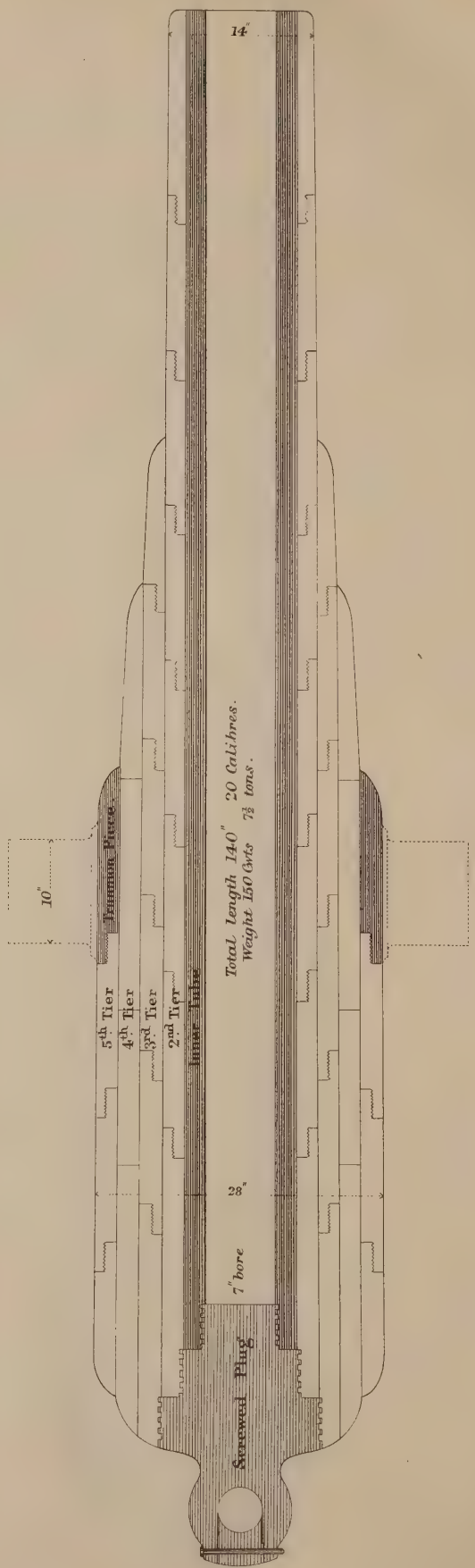


10 PARTS.

W. 5
769.

Mr WHITWORTH'S 7 INCH M.L. GUN AS PROPOSED BY MESSRS WHITWORTH & Co

Scale ⅛ of an inch to a foot.



John Anderson.

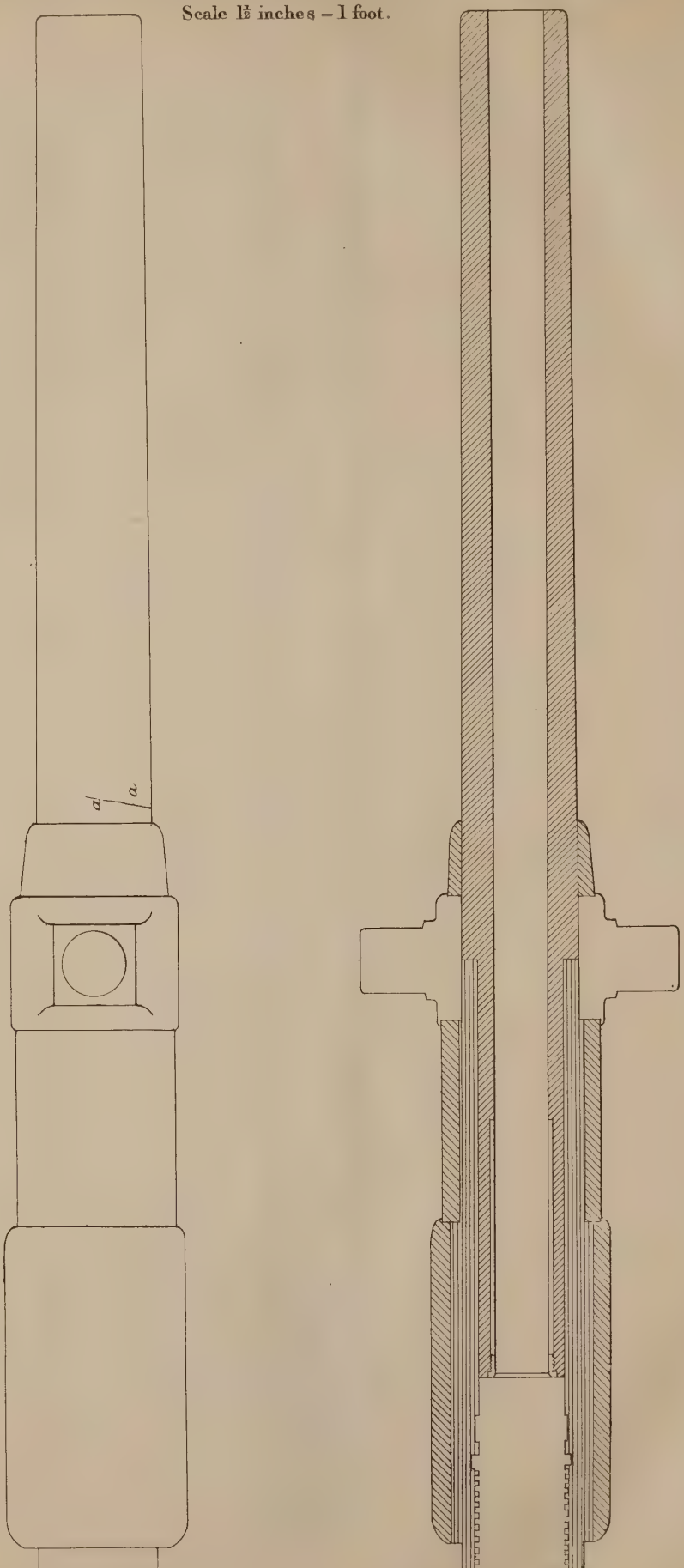
No 487. Ordered, by the House of Commons, to be printed, 23 July 1863

ROYAL GUN FACTORIES.

W. 764. C 4

12 Pr. LAND SERVICE ARMSTRONG GUN (No. 160.)

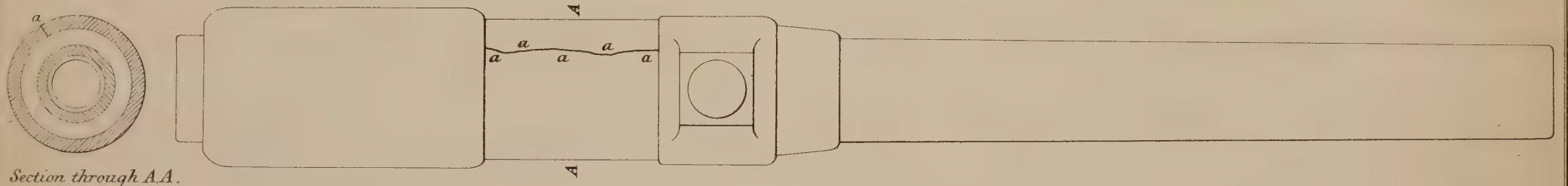
Scale 1½ inches = 1 foot.



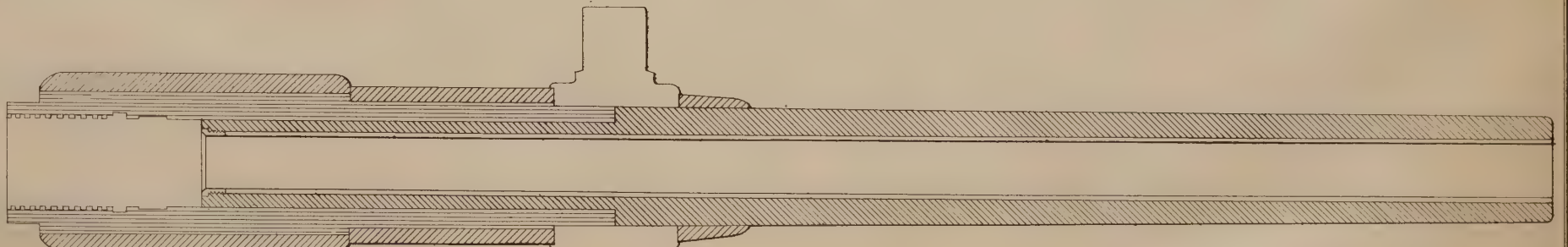
No. 487. Ordered, by the House of Commons, to be printed, 23 July 1863

12 Pr. LAND SERVICE ARMSTRONG GUN (No. 287.)

Scale, 1½ inches – one foot.



Section through A.A.



To face page 467.

No. 187. Ordered, by the House of Commons, to be printed, 23 July 1863.

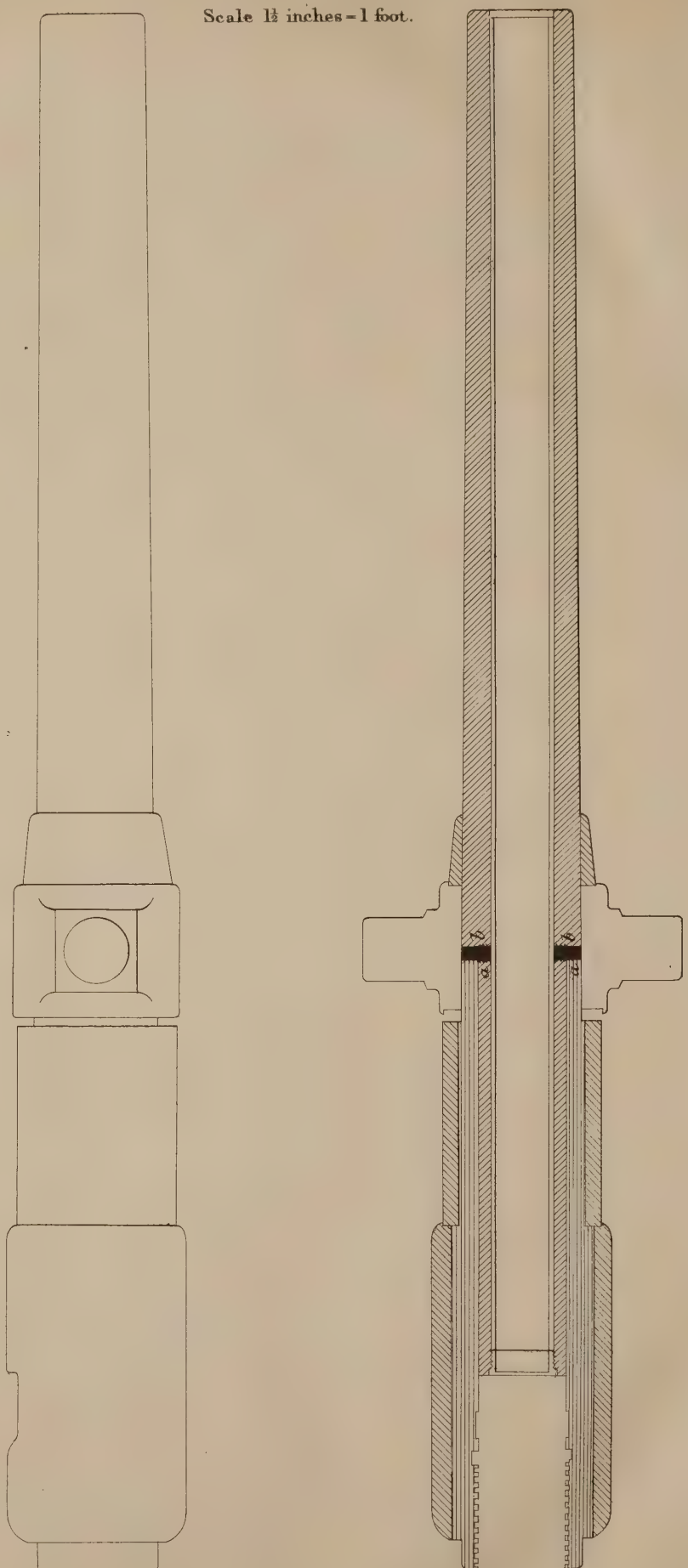
See page 467.

ROYAL GUN FACTORIES.

W. 762. A

12Pr LAND SERVICE ARMSTRONG GUN (No. 198.)

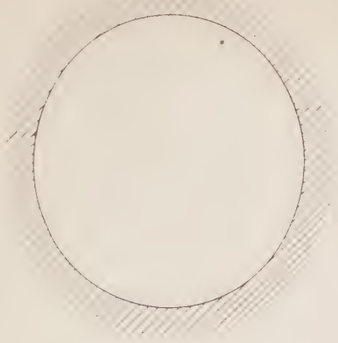
Scale 1½ inches = 1 foot.



No. 487. Ordered, by the House of Commons, to be printed, 23 July 1863

W.
761.

1



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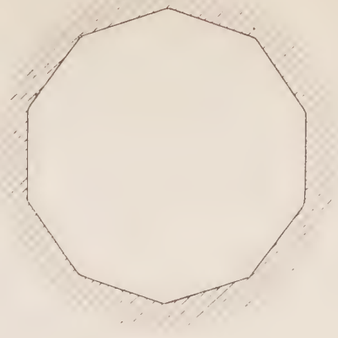

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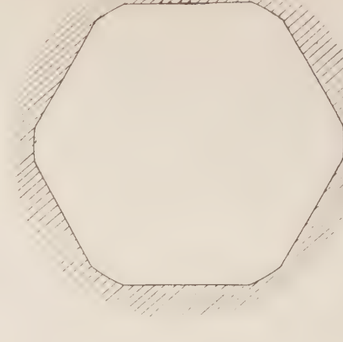

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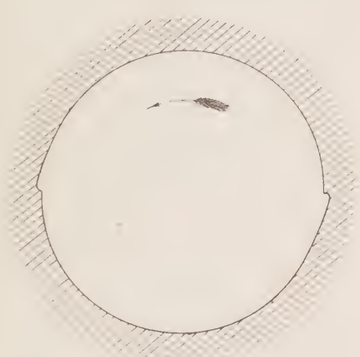

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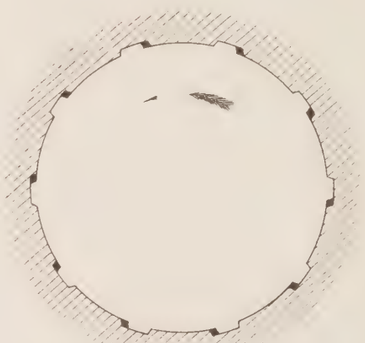

TABLE OF EXPERIMENTS
ON
CAST IRON RIFLE SOCKETS.

No. of Diagram.	Name.	Nature of Rifling.	Breaking weight in Tons at Circumference.
1	*Mr. Lancaster's*	*Oval*	*7 · 02*
2	*Experimental*	*Decagon*	*23 · 29*
3	*Sir W. Armstrong's*	*3 Grooved Shunt*	*25 · 65*
4	*Commander Scott's*	*3 Grooves in Socket but only 2 Ribs bearing.*	*27 · 95*
5	*Mr. Whitworth's*	*Hexagon*	*28 · 07*
6	*Commander Scott's*	*2 Grooves Opposite to each other*	*29 · 00*
7	*Experimental*	*2 Grooves Opposite to each other.*	*29 · 18*
8	*Mr. L. Thomas'*	*3 Ribs.*	*35 · 09*
9	*Commander Scott's*	*3 Grooves.*	*35 · 30*
10	*Sir W. Armstrong's*	*10 Grooved Shunt*	*46 · 50*

No. 487. Ordered, by the House of Commons, to be printed, 23 July 1863

Appendix, No. 38.

FIFTEEN Diagrams.—(*See opposite.*) App. No. 38.

Appendix, No. 39.

PAPER put in by Major General *Alexander T. Tulloh.* App. No. 39.

RETURN of PAPERS connected with the condemnation and disposal of obsolete ARMSTRONG FUZES.

CONCUSSION FUZES.

Report of the Ordnance Select Committee, dated the 12th September 1862, No. 2457, upon the subject of Bursters and Concussion Fuzes.

THE Committee having attentively considered this subject are of opinion— 57—2—7007.

1st. That all 25-pounder iron bursters be returned to Woolwich, for conversion into 20-pounder bursters.

2d. That all old pattern 12-pounder bursters be returned to Woolwich, for conversion into 9-pounder bursters.

3d. That all iron concussion fuzes be broken up.

4th. That, in order to adapt the 20-pounder burster for use with the 25-pounder segment shell, a wooden plug be supplied. This plug to be dropped into the shell before the burster is inserted, for the purpose of filling up the vacant space in the shell caused by the reduction in size of the burster.

The Committee have been guided in the recommendations above made with reference to the 25-pounder bursters, by the consideration of the great inconvenience and confusion likely to arise should two descriptions of bursters, fuzes, and segment shells, for one description of gun, be retained in the service; the only other alternative being the withdrawal and breaking up of the whole of the 25-pounder segment shells. With regard to the alterations recommended in the old pattern 12-pounder bursters, the Committee consider this will prevent much inconvenience, and, combined with the withdrawal of all iron concussion fuzes, enable the issue simultaneously of bursters and fuzes suitable for use together.

(signed) *W. Wiseman,* V.P.

These recommendations of the Committee having come under the notice of the Deputy Adjutant General, R.A., that officer expressed it as his opinion that, instead of withdrawing or changing any of the ammunition belonging to the 9-pounder and 12-pounder field batteries, it would be better to authorise the expenditure of the whole of it at practice during the present year (1863), and replace it with the best and newest inventions. 57—2—7007.

This course was approved, and the following communication was made to the Horse Guards:— 57—2—7007.

War Office, 2 Dec. 1862.

The Deputy Adjutant General is informed that the Secretary of State has decided that the ammunition now in possession of the Field Artillery is to be used up at the ordinary annual practice of the batteries; but that care must be taken that the proportions laid down by the regulations are not exceeded upon the ground that such ammunition is likely to be soon replaced by some of a superior description. 57—2—7007.

(signed) *Alexander T. Tulloh,*
Department of Ordance.

The Deputy Adjutant General, R.A.

On the 26th of January orders were given for breaking up the concussion fuzes then in store, the number of which, in possession of the principal Superintendent of Stores at Woolwich, 57—2—7312.

App. No. 39.

wich, appears from the Appendix, No. 34, to the Report of the Select Committee on Ordnance, 1863, to have then amounted to 12,149. It is not at the present time possible to state what number of these fuzes remain in possession of the Artillery and Navy, but they will continue to be used up until they can be replaced by fuzes of a superior pattern.

Time Fuzes.

57—7—669.

As regards time fuzes, the Ordnance Select Committee reported as follows, on the 3d October 1862:—

The Committee have the honour to report that they have carefully considered the observations of the Commandant of the School of Gunnery, in respect to the unsatisfactory state of the time fuzes for Armstrong guns.

Colonel Taylor's report on the failure of these fuzes, in so many instances, expresses all the Committee have to say upon the subject.

It appears sufficiently proved that the old pattern time fuzes, that were at one time considered perfection, are now very faulty; and this deterioration may arise from the fuzes of this description not standing the test of time and vicissitudes of weather, thereby proving their unfitness for the service, or from the fuzes when first made for experiment having been manufactured with an amount of care which cannot be bestowed in the manufacture of large quantities.

On account of the inefficiency of the old pattern B fuze, the Committee recommended for sealing (Report No. 2,371, 12/7/62, Minute 6812) a new time fuze, E 2, which they believe will be found to be free from all the objections found in the old one. Every precaution has been taken to protect these new fuzes from deterioration through damp, and the Committee hope that they will prove as successful when manufactured for service as they have done when supplied for experiment.

The Committee entirely concur in Colonel Taylor's recommendation, that the old pattern time fuzes should be withdrawn at once; and, with this view, they recommend that the new pattern E 2 time fuze be supplied, as speedily as possible, to all batteries and to all Her Majesty's ships, for boat and field service at foreign stations, and the old pattern fuzes withdrawn; that no battery or ship be allowed to proceed abroad without being supplied with the E 2 time fuze and the new concussion fuze; and that all batteries and ships at home stations be furnished with the new fuzes, as fast as they can be manufactured and supplied.

The fuzes (time) for the larger natures of Armstrong guns are still in a most unsatisfactory state, and the Committee are of opinion that no time should be lost in calling the attention of Sir William Armstrong to this serious defect in the system of projectiles for the naval and garrison service.

(signed) *W. Wiseman*, V. P.

9 October 1862.
75—7—669.

In consequence of this Report the manufacture and issue of the old pattern time fuzes was at once stopped. On reference to Appendix No. 34 (quoted before), it appears that 164,734 were made, and 162,431 issued, and 2,303 remain in store at Woolwich. Those

75—7—757 and 758.

remaining in possession of the Royal Artillery and the Navy were ordered to be returned into store on their being replaced by fuzes of the new pattern. No information has as yet been received as to the number to be broken up.

Alexander T. Tulloh, Major General,
Director of Ordnance.

9/5/63.

Appendix, No. 40.

COPY of the REPORT of Captain *Seymour*, of the Practice with ARMSTRONG GUNS on *Garden Island*, dated Her Majesty's ship "Pelorus," at Sydney, 19 March 1862; And COPY of the REPORT of the ACCIDENT to an ARMSTRONG GUN on Board Her Majesty's ship "Harrier," in October 1861. App. No. 40.

Sir, "Pelorus," Sydney, 19 March 1862.

I HAVE the honour to forward to you, for their Lordships' information, a report of practice from the Armstrong 12-pounders belonging to the "Miranda" and "Harrier," which took place by my orders, on the 4th instant, on Garden Island, in this harbour; and a return showing the number of Moorsom's shells fired from the ships above-mentioned, in a seaway and with some motion, on the 5th instant, on which day I proceeded with them outside the Heads of Port Jackson.

2. It will be seen by the latter return, that only one Moorsom's shell, a 32-pounder, fired from a 32-cwt. gun, with full charge, failed to explode at the proper time; it burst immediately after leaving the muzzle of the gun, but the explosion of the others was most accurate.

3. I may mention, that between April 1860 and March 1861, two vent-pieces have been blown out of the Armstrong guns belonging to Mercer's Battery in New Zealand (both when the guns were fired with blank cartridge at a field-day), and that the vent-piece of the "Harrier's" gun was blown out while her boats were shelling a town in the Fijis, as reported in my letter, dated 27 November 1861, No. 82.

I have, &c.

The Secretary of the Admiralty, &c. &c. &c.

(signed) *F. Beauchamp Seymour*, Commmodore.

RETURN of Practice with MOORSOM'S SHELL from H. M. Ships "Miranda" and "Harrier" on 5th March 1862.

Number of Shell Fired.	Description of Gun.	Charge used.	Range.	Number burst before reaching object fired at.	REMARKS.
"Miranda:"		*Lbs. oz.*	*Yards.*		
7 in Number	68-pounder -	12 1	400 to 800	one - -	Fired with a full charge from a 32-pounder, 32 cwt. gun.
	32-pounder -	5 2			
	45 cwt. -	7 2			
	32-pounder -	5 1			
	32 cwt. -	3 1			
"Harrier:"					
14 - -	32-pr., 56 cwt.	8 1	500 - -	none - -	All burst on striking.
	32-pr., 32 cwt.	5 4			
	32-pr., 32 cwt.	4 4			

(signed) *F. Beauchamp Seymour*, Commodore.

App. No 40.

RETURN of Practice with ARMSTRONG GUNS from *Garden Island, Port Jackson*, on the 4th March 1862.

Number of Rounds Fired.	Range.	If Leading of Projectile stripped.	REMARKS.
"Miranda:"			
13 - -	1,370 yards -	No. 3, 7, and 11 shots -	The shot have been carefully kept in the boxes in which they were supplied, and no reason can be assigned for their stripping.
12 - -	1,150 „ -	None.	
2 - -	2,900 „ -		

(signed) *F. Beauchamp Seymour*,
Commodore.

PROCEEDINGS of the "Harrier" at Fiji.

Sir, "Pelorous" at Sydney, 27 November 1861.

IN my letter to you of the 10th ult., No. 66, I had the honour to inform their Lordships that on the 19th of September I had dispatched the "Harrier" to the Fiji's, in consequence of information having been conveyed to me by Mr. Pritchard, Her Britannic Majesty's Consul, that certain natives of the islands of Viti Lesa and Kautora had lately maltreated some of the European residents there. The "Harrier" returned to Auckland on the 8th instant, and from Sir Malcolm M'Gregor's report of his proceedings, I gather that he had fulfilled the object for which I had sent him to the Fiji's; but in order to do so, he had been compelled to burn the towns of Vatia and Kinaya, an operation which was accomplished without loss of life to either the Europeans or Natives.

2. On his arrival at Rewa, island of Viti Levu, he found that the French frigate "Cornelie," Captain Lesacque, had arrived at Levuka, in the island of Oralan, from the Pacific station, on a mission similar to his own. Captain Lesacque's proceedings were summary enough, for he detained the Tui Viti (king Rakomtan) on board the "Cornelie" until a tongan, accused of destroying the property of a French subject had been delivered up to him, and having obtained the tongan, sailed forthwith for New Caledonia, where his prisoner is to be employed for two years on the public roads. I hope that the simultaneous appearance of two ships of war of different nations at the Fiji's, and the proceedings of their commanders, may prevent a repetition of the occurrence which formed the subject of complaint. The lower class of Fijians, however, are under little or no control of their chiefs, and Mr. Pritchard informs me that almost all the acts of which he complained were perpetrated after my visit to the Fiji's in July last, the natives being under the impression that they were safe from the visit of an English man-of-war for a year after the "Pelorous" left them.

4. I have every reason to be satisfied with the manner in which Sir Malcolm M'Gregor conducted the service on which he was employed, excepting in one trifling instance, which was, that two natives who, by their own admission, had been concerned in burning the property of and otherwise maltreating a British subject, having been sentenced to corporal punishment, by a court partly composed of their own chiefs, he carried the sentence into execution on board the "Harrier," instead of on shore.

5. I regret to report that a serious accident occurred in the "Harrier's" pinnace while clearing the town of Kinaya, previous to its being set on fire. The vent-piece of the Armstrong 12-pounder which she carried having been blown out and six of her men wounded, one of whom, George Mould, seaman gunner, was severely burnt. Mr. Pritchard, Her Majesty's Consul, and Mr. Scomond, the master, were also injured by the explosion.

I enclose a report from Sir Malcolm M'Gregor on the state of the gun.

I have, &c.
(signed) *Beauchamp Seymour*,
Commodore.

The Secretary of the Admiralty.

App. No. 40.

H. M. S. "Harrier," Auckland, New Zealand,
7 December 1861.

Sir,

Referring to my letter of proceedings, dated 8 November 1861, in which I mentioned that the vent-piece had been blown out of the Armstrong gun, I have the honour to inform you, that, upon reflection and inquiry, I can only arrive at the conclusion that either the cartridge was not quite home, or that something prevented the vent-piece from dropping close down into its place. I myself heard the cams tap, and the sound appeared correct; although the cone could not have been accurately in its seating, the breech-screw must have been very tightly screwed up, because the shot was projected, and, therefore, the vent-piece must have stood a very severe strain before quitting its place. Captain Strover, R.A., when he came on board to examine the vents of our broadside guns, told me, that a similar accident had occurred on two recent occasions to the Armstrong guns of the Royal Artillery. As at present fitted, I have no doubt, when in its proper place, no accident can occur, but the smallest inaccuracy, so slight as to be almost imperceptible, is likely to be attended with serious consequences. With a view to rendering accidents less frequent, I would suggest whether it would not be possible to fit the vent-piece in such a manner that, if it were not properly screwed up, any one would immediately observe it.

I have, &c.
(signed) *Malcolm MacGregor*,
Commander.

Commodore F. Beauchamp Seymour, C.B.,
Commanding Australian Station,
H. M. S. "Pelorous."

Admiralty, 11 May 1863.

C. H. PENNELL,
Chief Clerk.

Appendix, No. 41.

App. No. 41.

List of Vent Pieces cracked whilst carrying on Experiments with Captain Coles's Gun Shield, on board Her Majesty's Ship "Trusty."

The	1st,	marked	E. O. C.	Iron,	cracked	at the	14th round.
	2d	„	„	Iron	„	„	2d „
	3d	„	„	Iron	„	„	6th „
	4th	„	„	Iron	„	„	2d „
	5th	„	„	Iron	„	„	3d „
	6th	„	„	Steel	„	„	10th „
	7th	„	„	Iron	„	„	2d „
	8th	„	„	Iron	„	„	18th „
	9th	„	„	Steel	„	„	9th „
	10th	„	„	Steel	„	„	16th „
	11th	„	„	Steel	„	„	5th „
	12th	„	„	Steel	„	„	4th „

Out of these, No. 6 and 10 cracked when used in the main deck gun, and No. 11 in the "Cochin's" gun when firing at the shield; all the rest in the shield gun. Nos. 1 and 5 injured the copper ring in rear of the chamber, which required replacing before we could continue the experiments.

(signed) *Wm. H. Liddell*,
Gunnery Lieutenant,
of H. M. S. "Excellent."

Appendix, No. 42.

App. No. 42.

EXTRACT Bombay Military Letter, dated 2 February 1863.

17. WE have the honour to communicate the accompanying copy of a letter from the Inspector General of Ordnance and Magazines, No. 401, dated 23d January last, and of its accompaniments, reporting on a 12-pounder Armstrong gun, injured at practice, and also on the other guns comprising the battery.

(No. 401.)

From the Inspector General of Ordnance and Magazines to the Secretary to Government, Military Department, dated 23 January 1863.

Sir,

WITH reference to Government Resolution, No. 1788, dated 6th June last, and previous correspondence regarding the two batteries of 12-pounder Armstrong guns sent out by the Home Authorities for use in this Presidency, I have the honour, under instructions from his Excellency the Commander in Chief, to annex, for the information of his Excellency the Governor in Council, the Proceedings of a Board of Artillery Officers assembled at Kirkee to report on a 12-pounder Armstrong gun injured at practice, and also on the other guns comprising the battery, together with the sketch alluded to therein.

2d. The subjoined is a copy of a letter addressed by the Armstrong gunnery instructor to the staff officer at Kirkee:

"I beg to acknowledge the receipt of your memo., together with the accompanying letter from the acting Assistant Adjutant General, R.A., No. 4156, and in reply to the questions therein called for, have the honour to report, that during the entire instruction practice with the Armstrong guns, loading, firing, and general working of the guns, was conducted slowly and strictly in accordance with the drill laid down in the latest manual of field artillery exercise. The gun commanders were specially instructed not to allow the projectile or cartridge to be entered till the bores and chambers of the guns were thoroughly sponged out. This was effected with a wet sponge after each round. The Armstrong gun, on removal of the vent-piece or stopper of the bore, is a hollow tube open at both ends, so that after sponging, should any residue remain in the bore, it can be easily detected by the gun commander, and removed at his order by the number whose duty it is to sponge out. I am of opinion that no possible harm could have occurred in this respect, as the guns were thoroughly cleaned after each round.

"During the practice, very few projectiles stripped. Previous to each day's firing, each shot was carefully inspected, before being packed in the ammunition boxes. In those that stripped, no outward defect of the leaden coating was visible.

"Three guns only have been used for instruction practice. The remaining three have not been fired since their arrival at Kirkee, yet these three all show transverse marks, also flaws, as noted in the proceedings of the Board of Survey, dated 5th December 1862.

"The three that have been in use also showed these transverse marks previous to being fired. Though these three guns have fired about 112 rounds respectively, it was not till the fracture of the inner coil, close to the muzzle, of one of them occurred, any fear was entertained that any of the transverse marks were more than skin deep. I would particularly bring to notice that these transverse marks across the rifling existed not in one particular gun, but in every gun composing this Armstrong battery.

"The cause of these flaws existing may be attributed either to the strand of the coil in which these marks appear, not having been properly welded when the coil itself was welded and set up, or to bad material.

"An opinion in this respect should, I think, be taken from an experienced mechanic.

"I am not of opinion that there is any danger of any of the guns bursting, but there is a possibility from continual firing, that at that point of any of those scores across the rifling, the inner coil might give way, and a portion of the inner tube be blown out of the gun.

"During the instruction practice, the charge used was, viz., service charge, 1lb. 8 oz. of ordnance powder, manufactured at the Powder Works Bombay; each cartridge was weighed with the greatest care."

3d. I beg to suggest that the subject be brought to the notice of the Home Government.

I have, &c.
(signed) *J. B. Woosnam*, Colonel,
Bombay, 23 January 1863. Inspector General of Ordnance and Magazines.

PROCEEDINGS of a Board assembled at Kirkee on 9th day of December 1862, by order of Colonel Forster, commanding Artillery at Kirkee, to report on a 12-pounder Armstrong Gun injured at practice, as also on the other Guns comprising the Battery. App. No. 42.

PRESIDENT.

Lieutenant Colonel Sealy, R.A.

MEMBERS.

Captain Blunt, R.H.A.
Lieutenant Vachell, R.H.A.

THE Board having assembled pursuant to order, and having examined the guns, submit the following Report:—

No. 59. Weight 8 cwt. 2 qrs. 19 lbs. E. O. C. 1860: inner coil projecting one-third of an inch at the muzzle as shown in drawing annexed, arising as it appears from defective manufacture; 112 rounds had been fired from this gun when the fracture occurred.

No. 55. Weight 8 cwt. 2 qrs. 21 lbs. E.O.C. 1860: on the lower surface of inner coil, a transverse crack of ·15 of an inch in depth at about, 1 foot 7 inches from the muzzle; 112 rounds fired from this gun.

No. 53. Weight 8 cwt. 2 qrs. 20 lbs. E.O.C. 1860: on the right lower surface extending nearly to the upper surface, a transverse crack on the inner coil about 2 feet 7 inches from the muzzle, presents on wax an impression of the depth of ·15 of an inch, also another crack about 8 inches from the muzzle, extending transversely from lower surface in both directions, in all about one-fifth the circumference of the bore; also a deeper crack about 1¼ inch from the muzzle on the lower surface, extending through six bands of the rifling; 112 rounds fired at practice from this gun.

No. 46. Weight 8 cwt. 2 qrs. 20 lbs. E.O.C. 1859: at 1 foot 11 inches from the muzzle, a transverse crack over three bands of the rifling, very slight; not fired from in India.

No. 62. Weight 8 cwt. 2 qrs. 14 lbs. E.O.C. 1860: three feet from the muzzle on lower surface of the bore five bands are entirely broken away, and the wax shows an impression of a fissure of ·2 of an inch in depth; not fired in India.

No. 57. Weight 8 cwt. 2 qrs. 17 lbs. E.O.C. 1860: five inches from the muzzle, a transverse crack on the left side of the bore extending through five bands of rifling to the level of groove. At one foot four inches from the muzzle on right upper surface, a transverse crack extending over nine bands of rifling, one-twentieth of an inch wide and half the depth of a band in depth. The thread of the female breech screw shows deep scores, apparently at the welding point; not fired in India.

(signed) *E. P. Sealy*, Lieutenant Colonel, R.A., and President.
A. Blunt, Captain, R.H.A., and Member.
J. P. Vachell, Lieutenant, R.H.A., and Member.
W. Forster, Colonel, Commanding Artillery at Kirkee, and P.D.A.

ORDNANCE SELECT COMMITTEE.

(Committee Minute, No. 8976, 1/5/63.—Report, No. 2802. 6 May 1863.)

Present:—

Brigadier General, St. George, C.B., R.A.
Captain L. G. Heath, C.B., R.N.
Colonel Hogge, C.B., R.A.
Bt. Colonel F. Campbell, R.A.
Lieutenant Colonel R. S. Baynes, Unatt.
Lieutenant Colonel Gallwey, R.E.
Bt. Colonel Lefroy, R.A., Secretary.

SUBJECT:—Flaws discovered in six Armstrong 12-pounder Guns in India. Nos. 46, 53, 55, 57, 59, 62.

WITH reference to W. O. Minute 14/4/63, on 73—3—384, transmitting for early consideration, an extract from a military letter from Bombay, 2/2/63, with enclosures relating to a 12-pounder Armstrong gun, injured at practice at Kirkee, and also to the condition of the

App. No. 42. other guns of the Armstrong battery stationed at that place. A board of officers, assembled pursuant to order 9/12/62, submits the following report:—

No. 59, E. O. Co. 12-pounder gun (1860). Inner coil projecting one-third inch at muzzle, as shown in an accompanying drawing, arising apparently from defective manufacture; 112 rounds had been fired when the fracture occurred.

Guns No. 55, 53, 62, and 57, E. O. Co. (1860), and No. 49, E. O. Co. (1859), show more or less transverse marks and flaws in the inner coil across the rifling. Guns No. 59, 55, and 53, have fired each 112 rounds; the other guns have not been fired in India.

Committee's Report.

1. The Committee have the honour to report that on carefully perusing the Report of the Board of Survey, held at Kirkee, 9th December 1862, they are led to the conclusion that none of the flaws reported to have been discovered in the 12-pounder guns, are of any consequence, except that in gun No. 59, which will be removed by cutting off the muzzle and reducing the length of the gun by four inches. As it has been shown that the land service 12-pounder may be reduced to the length of the sea service 12-pounder without sensible loss of range or accuracy, and measures are actually in progress for carrying out this reduction, the Committee see no objection, as a temporary measure, to the shortening of No. 59 by four inches. The other so-called cracks appear to be of the kind which is incidental to all built-up coil guns of the earlier manufacture, and to arise from imperfect welds or superficial flaws alone. They are of a very different character from fractures of the metal, and with the exception of the slight flaw reported to exist in No. 53, at eight inches from the muzzle, which will also be cut off, should these guns be hereafter reduced in length,—they were all noted by the Inspector of Artillery before the guns were issued; a proof at least, that in the opinion of that department, they were of no practical importance. It is natural that officers accustomed to look with alarm at any fissures in a cast-iron gun should at first extend the same suspicion to every appearance of a fissure in a wrought-iron one, but the Committee would point out that the circumferential strength of the gun is not affected by imperfect junction of coils. Armstrong guns have never burst in the usual sense of the term, that is, parted into fragments which have been scattered with violence, except under such a long continuance of double charges in the proof of vent pieces, as sufficed to alter the fibrous character of the metal. In one instance a few inches of the muzzle of a 40-pounder were
Minute 5102. blown off, which was traced to a drill shot having been left in the gun; in another instance
Minute 5103. a few inches of the muzzle of a 20-pounder were blown off, which was undoubtedly due to an original flaw, or a bad weld; but neither accident was of a character to cause more than very slight risk to the gun detachments; the muzzles came off entire, without violence. A similar accident to a 12-pounder at Shorncliffe, is attributed to the gun having been dis-
Nos. 160, 198, 286, 287. mounted on soft sand, some of which remained in the muzzle. In four 12-pounder guns lately withdrawn from field batteries as unserviceable, separation had proceeded to a much greater extent than is described as having occurred in the guns in India. In No. 287, there is a true crack across the external coil, behind the trunnions. In No. 198, the rear half of the gun, comprising the breech piece and 3 A coil, has receded about half an inch from the front half, comprising the chase, 3 C coil, and trunnion piece, one layer of metal having slipped over the other. In Nos. 160 and 286, there are incipient openings in the chase externally, a few inches in front of 3 C coil, and others near the muzzle. These are the worst cases that have come to light, in an experience of several hundreds of wrought-iron coil 12-pounder guns, yet no accident of the nature of a burst has occurred, and the Committee feel warranted in affirming that the process of failure is so gradual, and the warnings given so ample, that none is to be apprehended, so long as confidence is not pushed to temerity. They see no present reason for withdrawing any of the guns reported on, and would simply recommend that the officers in charge of them, watch the effect of further practice upon them, and be guided by their own judgment as to returning them unserviceable. This should only be done in case the flaws, cracks, or openings, extend themselves in a threatening manner. In such case, the earliest opportunity should be taken of returning them to Woolwich for examination and report.

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2. Minute by the Elswick Ordnance Company, dated 29/4/63, on the Report of the Board of Survey.

"We think that the records of the Inspector of Artillery will give information as to the flaws existing in these guns after proof."

"None of the flaws appear to us, from the information given by the Board of Survey, to be of any importance, with the exception of the one of which a sketch is given. It is due to a defective weld, and the Committee will recollect the difficulties which were at first experienced with the inner barrels, but as it appears to be only about 1½ inches from the muzzle, the defect would be easily removed by shortening the gun to the above extent."

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3. MINUTE by the Inspector of Artillery, dated 4/5/63, on the Report of the Board of Survey. App. No. 42.

"WITH the exception of the crack 1½ inches from the muzzle of No. 59, and a slight flaw 8 inches from the muzzle of No. 53, all the cracks and flaws reported upon by the Board of Survey were in the guns when issued. I do not think them of much importance, excepting that the drawing of which has been forwarded. If E. O. Co.'s suggestion be carried out, the gun No. 59, will be rendered quite serviceable."

(signed) *J. St. George*, Brigadier General, President.

Appendix, No. 43.

REPORT of EXPERIMENTS at *Southport* in 1860, with 80-Pounder or 12-Pounder WHITWORTH GUNS. App. No. 43.

(80.—W.—303.)

IN obedience to our instructions, we went to Southport on the 25th July, and carried on practice with Mr. Whitworth's 80-pounder and 12-pounder guns. Detailed reports of the practice on that and the following day are herewith. The guns were fired a few rounds by Mr. Whitworth's men previously; but of these we took no note. They were then handed over to the Royal Artillery, and to seamen of the Royal Navy; and the practice recorded was carried on entirely under our direction, and that of Commander Herbert of the "Excellent," who was sent down for the purpose by the Admiralty: a man of Mr. Whitworth's, accustomed to fire his guns, looking over the sights on each occasion before firing, and pointing out anything he thought required alteration. The ranges and deflections were taken by a party of artillerymen under an officer, and are, we believe, correct.

The 12-pounder gun is made of homogeneous iron. The 80-pounder is of the same metal, strengthened in its whole length by wrought iron rings. Metal.

The system of breech-loading is described by Lieutenant Colonel Campbell in 80.—W.—223. Breech loading.

The amount of twist of the 80-pounder, is one turn in eight feet four inches; of the 12-pounder, one turn in five feet. The rifling consists of six grooves and six lands; the grooves being about three times the breadth of the lands. Rifling.

The powder used was "A. 4," supplied by this department. It was placed in a tin case described in 223. Gunpowder and cartridge.

The projectiles were shot and blind shell. Projectiles.

The number of rounds fired by us was,

80-pounder	25
12-pounder	55

the supply of powder then failed; and as we had seen sufficient of the range and accuracy of the guns, and had experience of the ease and facility of working them, we terminated the experiment and returned to London.

We observe that Mr. Whitworth now calls the heavy gun an "80-pounder;" but as we fired no projectile above 70 lbs. from it, there seems no good reason for his altering its denomination from that of a "70-pounder," which he previously designated it.

The weight of this 80 (or 70) pounder is stated to 80 cwt. 20 lbs.; this is greatly in excess of the service breech-loader. The 100-pounder, in course of manufacture by Sir W. Armstrong, is to weigh 65 or 70 cwt., and this increase will be an evident inconvenience. It must be remembered that while the service gun throws a shell of 100 lbs., containing 8 lbs. of powder, Mr. Whitworth's heavier gun throws a shell weighing 57¾ lbs., containing 2¾ lbs. of powder only. Weight.

The weight of Mr Whitworth's 12-pounder is 9¾ cwt.*; that used in the experiments in February

* *Note.*—Mr. Whitworth called this morning and told me that this is a mistake, that the gun weighs between 8 and 9 cwt., he does not exactly remember what.

2 October. (signed) *J. St. G.*

App. No. 43.

February weighed 8cwt.; and there must have been some idea that it was wanting in strength, to account for the additional 1¾cwt. in this.

The 12-pounder B.L. service guns weigh 8cwt., and 6cwt.

Cartridge.

The tin cartridge is very cleanly and ingenious; but we are of opinion that it is not suited for the contingencies and rough usage of the service, either on sea or land. It must be very liable to injury, and to be bent out of shape; and as the gunpowder is not in any way secured in the cartridge, and is merely covered by about a quarter of an inch of a substance consisting of tallow and wax, the cartridge must always be held upright, and can only be filled when wanted for immediate action, as it would be impossible to carry it filled in the timber boxes.

Shells.

The shell produced for this experiment was very rude and immature. Its small internal capacity, and consequent thickness of metal, render it very doubtful in our minds, whether the quantity of powder it will hold (2¾lbs. for the 80-pounder) would be enough to burst it. The projectile, in fact, could hardly be styled a shell. Mr. Whitworth does not appear to have given his attention to any system of shell firing, and has no fuzes, or other necessary arrangements matured.

We take occasion to remark that the chief, if not the sole, advantage expected from large rifled guns, is their capability of throwing shells containing large bursting charges, to considerable distances with precision.

Mr. Whitworth's shells are of far less weight than the shot for the same gun.

The service breech-loading guns use but one weight of projectiles, which is a manifest advantage.

Preponderance.

The 12-pounder gun appears to have been constructed on faulty principles; the preponderance being excessive. We did not ascertain its amount, but it required five strong gunners to limber it up; whereas the breech-loading 12-pounder of the service, takes only two men. This could be remedied in future constructions.

Endurance.

We observed at the close of the practice, an oily substance oozing out at the junctions of the rings which strengthen the gun on the chace; and also at the face of the piece where the outer and inner cylinder meet.

This shook our confidence in the stability of the gun; and it would, at any rate, be necessary to subject it to severe proof, before placing it on board ship or elsewhere for practice.

We are of opinion that guns rifled on this principle have great range, and throw their shot with much precision; that the system of breech-loading adopted by Mr. Whitworth, renders the loading easy and convenient, and prevents any escape of gas; that the guns have the great advantage of being very clean for the men working them, if not fouling, and of not requiring sponging. But we feel it would be impossible for us to recommend the purchase of any number of these guns, until the advantages and disadvantages of the construction had been throughly investigated; and until one or more specimens had undergone all the trials to which every like invention should be subjected, before adoption into Her Majesty's service, even on the most limited scale.

We are of opinion that sufficient promise of advantage has been given to warrant the purchase of an 80-pounder, and a 12-pounder; and we recommend that one of each of these guns be bought, and a series of experiments be made with them, to ascertain their real value.

(signed) *J. St. George.*
Ch. Bingham, D.A.G.R.A.

No. 1.—Report of Experimental Practice.—Southport, 25 July 1860.

Height of Axis of Gun above plane, 4 feet 2 inches.

Ordnance - Nature, 12-pounder breech-loading Whitworth.
Weight, 9¾ cwt. (stated).
Length, 8 feet 4 inches.
Diameter of bore, 3 inches and 2·73 inches.
Spiral, if rifled.—Yes.
Grooves number, Width, inches. Depth, inches.

Barometer, .
Wind, very little.
Direction of wind.

Nature and object of the Experiment:—

Programme received, Stores received, Minute No.

No. of Round.	Charge.	Elevation.	Recoil.	Projectile. Nature.	Projectile. Weight and Mean Weight.	Projectile. Windage in Inches.	Times and Mean Time of Flight.	Range, 1st Graze.	Mean Range, 1st Graze.	Deflection. Correction allowed for.	Deflection. Left.	Deflection. Right.	REMARKS.
	Lbs.	*Deg.*	*Inches.*		*Lbs.*		*Seconds.*	*Yards.*	*Yards.*		*Feet.*	*Feet.*	
1	1¾	5	Not measured	Shot	12	–	7·25	2,590	–	none	10	–	
2	These three shots cannot be taken into account, as it was found that the tangent scale had not been removed, and had shifted from the proper elevation.												The platform was partly horizontal, and partly inclined 1 in 6.
3													
4													
5	1¾	5	35	Shot	12	–	6·75	2,540	2,543	none	15	–	
6	„	„	34	–	–	–	7·	2,575		„	6	–	
7	„	„	34	–	–	–	7·	2,501		„	7	–	
8	„	„	43	–	–	–	7·12	2,603		„	–	2	Recoiled off plank.
9	„	„	35	„	„	–	7·	2,570		„	2	–	
10	„	„	37	„	„	–	7·	2,470		„	–	9	
11	„	3	37	„	„	–	5·5	1,739	1,741	„	8	–	
12	„	„	37	„	„	–	5·2	1,755		„	3	–	
13	„	„	32	„	„	–	4·5	1,810		„	–	4	
14	„	„	36	„	„	–	4·5	1,678		„	8	–	
15	„	„	35	„	„	–	4·5	1,721		„	2	–	
16	„	„	32	Shell	10	–	4·75	1,828	1,804	„	–	1	
17	„	„	35	„	„	–	4·75	1,810		„	–	5	
18	„	„	32	„	„	–	4·75	1,826		„	10	–	
19	„	„	30	„	„	–	5·	1,733		„	–	2	
20	„	„	30	„	„	–	4·75	1,824		„	–	1	
21	„	1	–	Shot	12	–	–	787	790	–	–	–	In line.
22	„	„	38	„	„	–	–	843		–	1	–	
23	„	„	38	„	„	–	–	771		–	–	1	
24	„	„	38	„	„	–	2·5	794		–	1	–	
25	„	„	39	„	„	–	2·25	757		–	4	–	
26	„	„	34	Shell	10	–	2·25	815	834	–	–	–	In line.
27	„	„	35	„	„	–	–	829		–	1	–	
28	„	„	34	„	„	–	2·	827		–	–	–	In line.
29	„	„	35	„	„	–	2·	823		–	1	–	
30	„	„	64	„	„	–	2·	886		–	–	–	In line.

No difficulty in loading.
No escape of gas
The gun was not sponged during the practice. It was mounted on a travelling field carriage.
Diameter of bore - Major axis, 3· inches.
Minor axis, 2·73 „

The Secretary Ordnance Select Committee. (signed) *J. St. George.*

EXPERIMENTAL Practice continued with Mr. *Whitworth*'s 12-Pounder Gun, Breech-loading.
Southport, 26 July 1860.

No. of Round.	Charge.	Elevation.	Recoil.	Projectile.			Times and Mean Time of Flight.	Range, 1st Graze.	Mean Range, 1st Graze.	Deflection.			REMARKS.
				Nature.	Weight and Mean Weight.	Windage, in Inches.				Correction allowed for.	Left.	Right.	
	Lbs.	*Deg.*	*Inches.*		*Lbs.*		*Seconds.*	*Yards.*	*Yards.*		*Feet.*	*Feet.*	
1	2	10	79	Shot	12	–	13·25	4,500		none	9	–	
2	,,	,,	79	,,	,,	–	13·5	4,523		–	9	–	
3	,,	,,	71	,,	,,	–	13·	4,498	4,500	–	15	–	
4	,,	,,	72	,,	,,	–	13·	4,515		–	–	7	
5	,,	,,	72	,,	,,	–	13·2	4,464		–	15	–	
6	,,	,,	71	Shell	10	–	13·75	4,556		–	36	–	
7	,,	,,	74	,,	,,	–	13·6	4,524		–	57	–	
8	,,	,,	73	,,	,,	–	14·	4,576	4,554	–	39	–	
9	,,	,,	70	,,	,,	–	13·5	4,555		–	–	20	
10	,,	,,	71	,,	,,	–	13·8	4,562		–	33	–	
11	1¾	7	63	Shot	12	–	9·6	3,305		–	6	–	
12	,,	,,	55	,,	,,	–	9·1	3,250		–	8	–	
13	,,	,,	58	,,	,,	–	9·5	3,192	3,243	–	32	–	
14	,,	,,	69	,,	,,	–	9·5	3,250		–	21	–	
15	,,	,,	62	,,	,,	–	9·7	3,217		–	9	–	
16	,,	,,	54	Shell	10	–	8·9	3,357		–	15	–	
17	,,	,,	57	,,	,,	–	9·5	3,386		–	16	–	
18	,,	,,	71	,,	,,	–	9·5	3,288	3,319	–	21	–	
19	,,	,,	67	,,	,,	–	9·4	3,315		–	14	–	
20	,,	,,	63	,,	,,	–	–	3,252		–	–	–	In line.
21	,,	5	55	,,	10	–	7·1	2,362		–	–	–	In line.
22	,,	,,	47	,,	,,	–	7·1	2,618		–	–	5	
23	,,	,,	60	,,	,,	–	7·5	2,606	2,572	–	14	–	
24	,,	,,	67	,,	,,	–	7·3	2,658		–	15	–	
25	,,	,,	69	,,	,,	–	7·5	2,616		–	21	–	Fresh breeze, W.S.W.

No difficulty in loading.
No escape of gas.
The gun was not sponged out.
It was mounted on a field-carriage.

(signed) *J. St. George,*

No. 2.—Report of Experimental Practice.—Southport, 25 July 1860.

Height of Axis of Gun above plane, 3 feet 2 ½ inches.

Ordnance - Nature, 80-pounder (Whitworth's). Barometer,
Weight, 80 cwts. 20 lbs. (stated). Wind, very little.
Length, 10 feet. Direction of wind,
Diameter of bore, 5 in. and 5 4/10 in.
Spiral, if rifled.—Yes.
Grooves, number, 6. Width, 6/10 inches. Depth, ¼ inch.

Nature and Object of the Experiment:—

Programme received, Stores received, Minute No.

No. of Round.	Charge.	Elevation.	Recoil.	Projectile. Nature.	Projectile. Weight and Mean Weight.	Projectile. Windage in Inches.	Times and Mean Time of Flight.	Range, 1st Graze.	Mean Range, 1st Graze.	Deflection. Correction allowed for.	Deflection. Left.	Deflection. Right.	REMARKS.
	Lbs.	*Deg.*	*Inches.*		*Lbs.*		*Seconds.*	*Yards.*	*Yards.*		*Feet.*	*Feet.*	
1	12	1	–	Shot	70	–	2·	797		None	1	–	The platform was partly horizontal and partly inclined 1 in 6.
2	,,	,,	100	,,	,,	–	1·6	737		,,	3	–	
3	,,	,,	101	,,	,,	–	1·6	727	760	,,	2	–	
4	,,	,,	102	,,	,,	–	1·7	767		,,	5	–	
5	,,	,,	102	,,	,,	–	1·8	774		,,	2	–	
6	,,	,,	80	Shell	55	–	1·9	876		,,	6	–	
7	,,	,,	109	,,	,,	–	2·1	994		,,	–	–	In line.
8	,,	,,	110	,,	,,	–	2·	959	967	,,	–	8	
9	,,	,,	112	,,	,,	–	2·	999		,,	–	7	
10	,,	,,	112	,,	,,	–	2·25	1,008		,,	4	–	

The Secretary, Ordnance Select Committee. (signed) *J. St. George.*

Experimental Practice continued with Mr. Whitworth's 80-pounder.—Southport, 26 July 1860.

No. of Round.	Charge.	Elevation.	Recoil.	Projectile. Nature.	Projectile. Weight and Mean Weight.	Projectile. Windage in Inches.	Times and Mean Time of Flight.	ange, st Graze.	Mean Range, 1st Graze.	Deflection. Correction allowed for.	Deflection. Left.	Deflection. Right.	REMARKS.
	Lbs.	*Deg.*	*Inches.*		*Lbs.*		*Seconds.*	*Yards.*	*Yards.*		*Feet.*	*Feet.*	
1	12	2	–	Shot	70	–	3·75	1,277		None	–	–	In line.
2	,,	–	130	,,	,,	–	3·25	1,283		,,	–	–	,,
3	,,	–	130	,,	,,	–	3·	1,301	1,297	,,	5	–	
4	,,	–	137	,,	,,	–	3·5	1,321		,,	–	4	
5	,,	–	137	,,	,,	–	3·5	1,302		,,	–	1	
6	,,	–	115	Shell	55	–	3·75	1,588		,,	–	10	
7	,,	–	116	,,	,,	–	3·	1,441		,,	–	9	
8	,,	–	116	,,	,,	–	3·1	1,409	1,494	,,	–	2	
9	,,	–	119	,,	,,	–	4·	1,561		,,	15	–	
10	,,	–	116	,,	,,	–	3·5	1,472		,,	10	–	
11	,,	3	140	Shot	70	–	4·	1,801		,,	–	7	
12	,,	,,	103	,,	,,	–	4·6	1,797		,,	–	10	
13	,,	,,	108	,,	,,	–	4·	1,784	1,786	,,	–	–	In line.
14	,,	,,	100	,,	,,	–	4·3	1,758		,,	5	–	
15	,,	,,	100	,,	,,	–	4·5	1,793		,,	7	–	Fresh breeze, W.S.W.

No difficulty in loading.
No escape of gas perceptible.
The gun was mounted on a heavy ship-carriage.
Projectiles turned to size in a lathe.
Diameter of bore - Major axis, 5·4 inches.
Minor axis, 5·0 ,,

(signed) *J. St. George.*

War Office, Pall Mall, S.W., 13 May 1863.

Alex. T. Tulloh, Major-General, Director of Ordnance.

Appendix, No. 44.

STATEMENT showing the Total Amount that has been Expended, and the Amount of Liabilities on existing Orders, &c., so far as the same can be ascertained, in the Manufacture of Guns and Projectiles on Sir William Armstrong's Principle.

	£. s. d.
Amount paid to the Elswick Ordnance Company, from March 1858 to the 6th May, including the sum of 70,295*l.* 8*s.* paid to that Company on account of compensation for termination of contract - - - - -	1,035,412 17 7
Amount expended in the Royal Carriage Department, Woolwich Arsenal, to the 31st March 1863 - - - - - - - - - - - -	210,182 17 –
Ditto - - - - - ditto - - - - - Royal Gun Factories - -	919,470 2 8
Ditto - - - - - ditto - - - - - Royal Laboratory - -	342,100 1 7
£.	2,507,165 18 10
Amount yet to be paid to the Elswick Ordnance Company upon completion of certain guns, for which they have received an advance of 256,351*l.* 12*s.* 3*d.*, on account of work in progress - - - - -	24,531 17 9
Amount yet to be paid to the Elswick Ordnance Company on account of orders for guns and projectiles in course of manufacture, upon which advances have not been made - - - - - - - - - -	12,611 5 1
Amount yet to be paid to the Elswick Ordnance Company to complete the sum awarded as compensation for the termination of contract - -	14,704 12 –
Total - - - £.	2,559,013 13 8

War Office,
7 May 1863.

H. W. S. Whiffin,
Assistant Accountant General.

STATEMENT showing the Cost of certain Guns and Projectiles obtained from the Elswick Ordnance Company, compared with the Rates of those produced at the Royal Arsenal, Woolwich.

DESCRIPTION.	ELSWICK ORDNANCE COMPANY.			ROYAL ARSENAL.		REMARKS. The Royal Arsenal Rates include Depreciation on Plant and Interest on Capital.
	Number.	Rates.	Total.	Rates.	Total.	
		£. s. d.	£. s. d.	£. s. d.	£. s. d.	
Guns:						
110-pounders -	209	700 – –	146,300 – –	387 10 9	100,372 4 3	This rate is the average for 1860–1 and 1861–2. *See* p. 236, Ordnance Report.
	50	588 5 –	29,412 5 –			
25-pounders -	1	230 – –	230 – –	184 5 4	5,712 5 4	This rate is for 1860–1. *See* p. 236, Ordnance Report.
	30	220 – –	6,600 – –			
12-pounders -	69	170 – –	11,730 – –	87 3 5	7,845 7 6	Ditto - - ditto.
	21	143 – –	3,003 – –			
Carried forward - - - £.			197,275 5 –	- -	113,929 17 1	

Cost of certain Guns and Projectiles obtained from the Elswick Ordnance Company, &c.—*continued.*

DESCRIPTION.	ELSWICK ORDNANCE COMPANY.			ROYAL ARSENAL.		REMARKS.
	Number.	Rates.	Total.	Rates.	Total.	The Royal Arsenal Rates include Depreciation on Plant, and Interest on Capital.
		£. s. d.	£. s. d.	£. s. d.	£. s. d.	
Brought forward - -	-	-	197,275 5 –	-	113,929 17 1	
Shot:						
110-pounders -	50	1 5 –	62 10 –			
	600	1 2 4	670 – –	– 9 5	310 15 –	This rate is for 1861-2. *See* page 233 of Ordnance Report.
	10	– 19 6	9 15 –			
40-pounders -	270	– 12 –	162 – –	– 4 $3\frac{3}{4}$	3,534 14 10	Ditto - - ditto.
	16,123	– 10 5	8,397 7 11			
25-pounders -	6,024	– 7 5	2,233 18 –			
	100	– 7 1	35 8 4	– 2 8	859 4 –	Ditto - - ditto.
	320	– 7 –	112 – –			
12-pounders -	234	– 6 3	73 2 6			
	550	– 5 6	151 5 –			
	5,208	– 5 –	1,302 – –	– 1 $9\frac{1}{2}$	1,941 5 5	Ditto - - ditto.
	6,519	– 3 6	1,140 16 6			
	9,159	– 3 4	1,526 10 –			
6-pounders -	402	– 4 3	85 8 6			
	1,092	– 2 2	118 6 –	– 1 2	389 4 –	Ditto - - ditto.
	5,178	– 2 $-\frac{1}{2}$	528 11 9			
Segment Shells:						
110-pounders -	2,721	1 5 –	3,401 5 –			
	11,349	1 1 3	12,058 6 3			
	39,353	– 18 5	36,237 11 1	– 14 $9\frac{1}{2}$	40,160 17 9	Ditto - - ditto.
	879	– 15 10	695 17 6			
40-pounders -	12,179	– 13 6	8,220 16 6	– 7 $8\frac{1}{4}$	4,865 – 8	Ditto - - ditto.
	478	– 10 10	258 18 4			
20-pounders -	300	– 7 10	118 8 9			
	55,481	– 6 –	16,644 6 –	– 4 $1\frac{3}{4}$	11,562 18 9	Ditto - - ditto.
12-pounders -	324	– 9 –	145 16 –			
	100	– 8 9	88 15 –			
	850	– 7 6	318 15 –			
	59,942	– 6 –	16,482 12 –			
	444	– 5 8	125 16 –			
	150	– 5 $-\frac{1}{4}$	37 13 1	– 3 $2\frac{3}{4}$	39,298 19 2	Ditto - - ditto.
	61,480	– 4 10	14,857 13 4			
	78,036	– 4 5	17,232 19 –			
	102	– 4 6	22 19 –			
	41,972	– 3 1	6,470 13 8			
6-pounders -	50	– 5 6	13 15 –			
	100	– 4 6	22 10 –			
	6,600	– 3 –	990 – –	– 2 $3\frac{1}{2}$	2,706 – –	Ditto - - ditto.
	16,866	– 2 5	2,037 19 6			
Common Shells:						
110-pounders -	62,131	1 3 9	73,780 11 3			
	35,258	– 17 9	31,291 9 6			
	8,024	– 15 5	6,185 3 4	– 11 6	61,509 9 6	Ditto - - ditto.
	1,560	– 14 9	1,150 10 –			
40-pounders -	20	1 – –	20 – –			
	50	– 19 –	47 10 –			
	50	– 17 4	43 6 8			
	52,125	– 13 –	33,981 5 –	– 5 $11\frac{1}{4}$	27,865 17 6	Ditto - - ditto.
	31,598	– 9 6	15,009 1 –			
	10,021	– 8 –	4,008 8 –			
Carried forward - - - £.			515,784 15 3	-	308,934 3 8	

Cost of certain Guns and Projectiles obtained from the Elswick Ordnance Company, &c.—*continued.*

DESCRIPTION.	ELSWICK ORDNANCE COMPANY.			ROYAL ARSENAL.		REMARKS.
	Number.	Rates.	Total.	Rates.	Total.	The Royal Arsenal Rates include Depreciation on Plant and Interest on Capital.
		£. s. d.	£. s. d.	£. s. d.	£. s. d.	
Brought forward - -	-	-	515,784 15 3	- -	308,934 3 8	
Fuzes :						
Concussion -	12	– 6 –	3 12 –			
	54,470	– 3 –	8,170 10 –			
	111,935	– 2 –	11,193 10 –			
	43,671	– 1 $4\frac{1}{2}$	2,183 11 3	– 1 $1\frac{3}{4}$	19,701 16 $-\frac{1}{2}$	This rate is for 1861–2.
	427	– 1 5	30 4 11			
	300	– 2 6	37 10 –			
	34,884	– 1 2	2,034 18 –			
	98,187	– 1 $-\frac{3}{8}$	5,062 15 3			
Time - -	53,289	– 3 6	9,325 11 6			
	110,638	– 2 6	13,829 5 –			
	516	– 4 –	103 4 –			
	5,201	– 1 9	455 1 9			
	738	– 4 2	153 15 –	– – $11\frac{1}{2}$	8,515 14 $-\frac{1}{2}$	Ditto - - ditto.
	100	– 4 10	24 3 4			
	7,137	– 2 10	1,011 1 6			
	50	– 5 11	14 15 10			
	50	– 3 1	7 14 2			
Pillar - -	162,896	– 2 10	23,076 18 8			
	3,965	– 3 5	677 7 1			
	143	– 3 3	23 4 9	– 1 8	13,950 6 8	Ditto - - ditto.
	200	– 4 –	40 – –			
	100	– 3 2	15 16 8			
	100	– 3 3	16 5 –			
		£.	593,275 10 11	- -	351,102 – 5	
Difference between the Woolwich and Elswick rates, showing upon those items which can be compared, that a saving would have been effected of 40·819 %, if the whole had been procured from Woolwich - - - - - -		-	-	- -	242,173 10 6	
		£.	593,275 10 11	£.	593,275 10 11	

War Office, 7 May 1863.

H. W. S. Whiffin,
Assistant Accountant General.

STATEMENT showing the Payments to the Elswick Ordnance Company on account of Armstrong Guns and Projectiles, and all Material connected therewith, in each Year since their introduction into the Service, including all Experimental Guns and Ammunition.

Year.	Amount.	Remarks.
	£. s. d.	
1858-59 - - - -	7,868 6 2	
1859-60 - - - -	31,551 2 9	
1860-61 - - - -	398,327 16 6	
1861-62 - - - -	397,785 6 7	
1862-63 - - - -	188,782 10 8	This amount includes the sum of 65,535 *l.* 4 *s.*, paid on account of compensation.
1863-64 (to 6 May 1863) -	11,097 14 11	This amount includes the sum of 4,760 *l.* 4 *s.*, also paid on account of compensation.
Total - - -	1,035,412 17 7	

War Office, 7 May 1863.

H. W. S. Whiffin,
Assistant Accountant General.

Appendix, No. 45.

LETTER from Sir *W. G. Armstrong*, C.B., to the Secretary of State, War Office. App. No. 45.

8, Great George-street, Westminster,
Sir, 7 November 1859.

I HAVE to acknowledge the receipt of your letter of the 4th instant (73—1—531), informing me of the arrangement which has been made as to amalgamating the Royal Gun Foundry, and its appurtenances, with the Rifled Ordnance Department at Woolwich, and appointing me to the charge of the limited factories, under the title of "Superintendent of the Royal Gun Factory."

I presume that this appointment will involve no alteration in the terms of the memorandum by which my former duties were specified, and by which the conditions under which I took office were defined.

I have, &c.
(signed) *W. G. Armstrong.*

LETTER from *J. R. Godley* to Sir *W. G. Armstrong*, C.B.

Sir, War Office, 12 November 1859.

I AM directed by Mr. Secretary Herbert to acknowledge the receipt of your letter of the 7th instant (73—1—534), and to inform you in reply, that the arrangement under which you have been appointed Superintendent of the Royal Gun Factory for Rifled Ordnance, makes no change in the terms and conditions of your original engagements.

I have, &c.
(signed) *J. R. Godley.*

Sir W. Armstrong, C.B.,
8, Great George-street, Westminster.

Appendix, No. 46.

App. No. 46.

ORDNANCE SELECT COMMITTEE.

(Committee Minute, No. 2917, 14/12/60.—Report, No. 1323. 19 December 1860.)

PRESENT:

Colonel St. George, C.B., R.A.
Captain Sir W. Wiseman, Bart., R.N.
Colonel Robinson, R.E.
Lieut.-Colonel F. Campbell, R.A.
Colonel Greattred, C.B., H.P., Unatt.
Colonel Lefroy, R.A., Secretary.

SUBJECT:—Effect of exposure to the weather on Armstrong Field Pieces.

COMMITTEE'S REPORT.

1. THE Committee have the honour to submit, for Mr. Herbert's information, some remarks which they have made on the effect of exposure to the weather on Armstrong 12-pounder guns, and to which they have given special attention in consequence of the doubts expressed as to whether they would not be seriously injured by an accumulation of rust on the exposed surfaces in the event of any accidental or unavoidable neglect.

2. As a preliminary measure, a new 12-pounder gun, No. 8, was demanded from the principal military storekeeper, and was left exposed to the weather without any protection, and untouched, in the courtyard of the Committee's house from September the 3d to October the 17th, a period of 45 days. It rained very constantly during this period, which is longer than it is ever likely to be necessary to leave guns unattended to. At the expiration of it, it was taken to the marshes, and fired without being cleaned or spunged, and its shooting properties, as far as dependant upon the velocity of the shot, were ascertained by means of Navey's electro-ballistic apparatus.

3. The condition of the gun was as follows:—Exterior very rusty; all the browning eaten away; bore rusty for a few inches from the muzzle, but clean beyond that distance. Breech-screw rusty at each end, but the rust did not extend beyond the exterior threads; vent-piece rusty, with verdigris on the copper face. Elevating screw, tappet ring, and handles very rusty.

4. In this state, and without any cleaning or spunging, the gun was fired, and it is a satisfactory proof that these superficial injuries affect its real properties very little, that the mean initial velocity deduced by Captain Noble from 13 rounds is only 14·2 feet per second less than that deduced from comparative practice with a standard gun. The results were,—

	Feet.
Standard gun, No. 224 - - -	1141·8
Exposed gun, No. 8 - - -	1127·6

The uniformity of the results was, as it happened, actually greater with the exposed than with the standard gun, and the average precision greater in the same ratio.

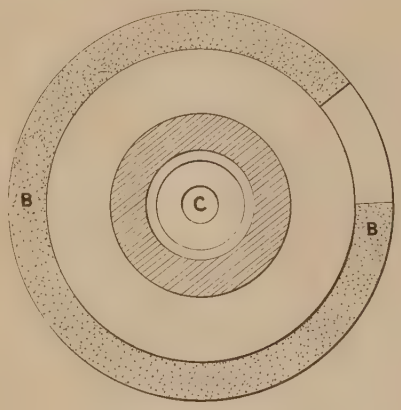
	Probable error.	Measure of precision.
Standard gun - -	1·54 ft. -	0·779
Exposed gun - -	1·18 ft. -	1·000

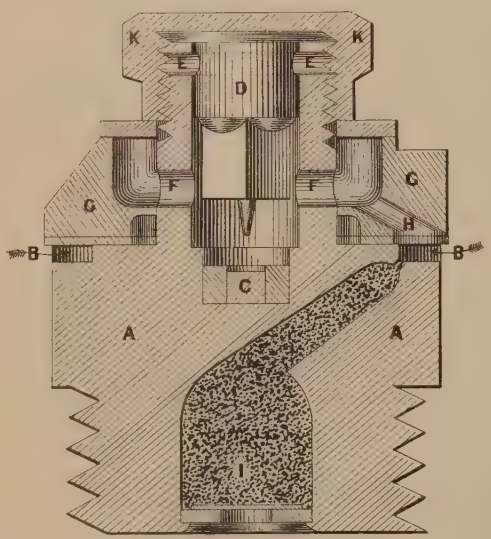
The gun was subsequently examined in the Royal Gun Factories, which reported as follows:—

5. "All the working parts of the gun were found in good order, and free from rust. The sights and drip-pan were in good order. The oil hole plug at the breech was rusted in. The exterior of the gun and the bore, for about nine inches from the muzzle, were slightly coated with rust." It was incidentally observed on this examination, that the thread of the breech-screw was cracked for nearly half a turn at the front end; this description of fracture, however, although a proof of bad metal, is not very serious, and cannot be connected with exposure to the weather. The screw was as efficient as ever on removing the unsound portion of the thread. It cannot be precisely ascertained when the injury occurred, but probably in the firing before mentioned.

6. The Committee's experience on this occasion is in accordance with that of the Superintendent School of Gunnery, who states that "None of the guns at Shoeburyness have deteriorated in the least degree from any exposure to which they have been subjected." He adds, "Although rust is sometimes

Fig. 29.

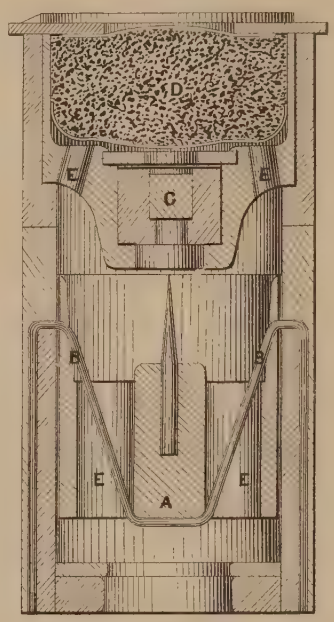




Time Fuze.

AA. *The Body of the Fuze.*
BB. *Groove containing the Fuze Composition.*
C. *The Detonator.*
D. *The Striker*
EE. *The Holding Pin.*
FF. *The Flame Passage.*
GG. *Revolving Cover, or Regulator.*
H. *Igniting Aperture.*
I. *Chamber for Priming Powder.*
KK. *Tightening Cap.*

Fig. 30.



Concussion Fuze.

A. *The Striker.*
BB. *The Holding Wire.*
C. *The Detonator.*
D. *The Chamber for Priming Powder*
EE. *Flame Passages.*

N°487 _Ordered, by the House of Commons, to be printed, 23 July 1863
Henry Hansard. Printer

sometimes allowed to accumulate on the guns from their being left in positions exposed to the weather, they have always been cleaned before being used for practice. This operation is easily performed."

7. Sir William Armstrong expresses his belief that no serious injury would arise if, from accidental cause, the guns should happen to be exposed to the weather for two or three weeks at a time, although it is extremely desirable that they should be regularly attended to, and as far as possible preserved from rust. He adds, that under such circumstances, " a tompion should be driven into the muzzle, the vent piece screwed hard up to the breech, and the breech screw be well oiled, as well as the collar of the lever where it fits upon the screw."

8. Recent experience in China confirms these anticipations.

Captain Milward, R. A., reports that on the arrival of his battery at Petang, 6 August 1860, being the eighth time of embarking or disembarking the guns in boats under circumstances of exposure, they were found " in excellent preservation, and fit for work," that he has " no difficulty in keeping them in order in all weathers and under all circumstances."

Lieutenant Colonel Barry reports, "The guns have sustained no injury, and have always been ready for service, as there has always been opportunity after they have been in action to have them well cleaned and oiled before they have been again required." He adds, however, " On the morning of the 22d August 1860, on returning to Singho, after having bivouacked at Sangku in the rain, the breech screws were nearly completely jammed with rust, and if we had had to renew hostilities at daybreak that morning, the gunners, who were already over fatigued, would have been severely tasked in getting the guns in order." A further proof that the intelligent attention of officers and men is required to them, but not a proof that they are too delicate for the greatest exposure of field service. App. No. 46.

Major Hay reports that undoubtedly the guns entail extra work upon the men, but that on all occasions when required, the guns, their screws, &c., were as clean and in as good working order as when in England.

9. Reviewing the above facts, the Committee have pleasure in expressing their conviction that there is nothing in the structure of the Armstrong gun to render it unsuitable for actual service, either in the field or the trenches. That it requires no more care than can easily be given to it under all circumstances, and that the superficial rust which sometimes cannot be prevented from forming, is only detrimental when suffered to accumulate to a degree which is inconsistent with any responsible oversight.

(signed) *J. St. George.*

Appendix, No. 47.

DIAGRAMS (The Time Fuze and the Concussion Fuze.) *See opposite.* App. No. 47.

Appendix, No. 48.

App. No. 48. COPY of an AGREEMENT entered into between the SECRETARY of STATE for WAR and the ELSWICK ORDNANCE COMPANY, dated 16 January 1859, and of the CORRESPONDENCE connected with the termination of the same.

— No. 1. —

DEFINITIONS of Sir *William George Armstrong*'s Duties, as "Engineer for Rifled Ordnance," and Terms of his Appointment.

1st. SIR WILLIAM GEORGE ARMSTRONG shall give his best attention to the maturing and perfecting of his system of rifled ordnance.

2d. He shall finish all designs and working drawings which may be required for the manufacture of rifled guns, and for the carriages, projectiles, fuzes, and implements connected therewith.

3d. He shall conduct all experiments and investigations which may be sanctioned by the War Department for the purpose of developing his system, or for the improvement of rifled ordnance generally.

4th. He shall from time to time, and as often as may be necessary, visit the various establishments in which guns and other articles designated by him shall be manufactured, and shall have authority to direct the methods to be adopted and the conditions to be observed in the construction of such articles, but he shall not be chargeable with the duties or responsibilities which usually devolve upon a resident superintendent.

5th. He shall report and advise upon all questions submitted to him by the War Department in relation to rifled ordnance.

6th. In cases where questions relating to rifled ordnance shall be referred to the decision of a committee, Sir William George Armstrong shall, if required, act under the direction of such committee. In other cases his duties shall be exercised, subject to the control of the Secretary of State for the War Department.

7th. Sir William George Armstrong shall not during his tenure of office take any patent for any further improvements which may be effected by him in relation to rifled ordnance, except by direction of the Secretary for War, and for the purpose of securing the advantages thereof to the Government.

8th. Sir William George Armstrong shall remain at liberty to carry on his present business or any other in which he may think proper to engage.

9th. His salary shall be 2,000*l.* a-year, commencing from the 1st of April 1856, and continuing to the 1st of April 1866, such salary from the 1st of January last to be clear of all disbursements as after mentioned.

10th. That on the 1st of April, 1st of July, 1st of October, and 1st of January in each year, all travelling expenses, after the usual scale allowed in the Office of the Secretary of State, shall be repaid to Sir William George Armstrong, and at the same period he shall be paid all expenses of draughtsmen employed by him, provided that such last-mentioned expenses, if they exceed the rate of 200*l.* per annum for any one quarter, shall receive the express sanction of the Secretary of State.

W. G. Armstrong.

War Office, 23 February 1859.

THIS INDENTURE made the 15th day of January 1859 between *William George Armstrong* of Newcastle-upon-Tyne Esquire of the one part and Her Majesty's Principal Secretary of State for the War Department of the other part Whereas the said William George Armstrong has devoted much time and attention to the subject of gunnery and has invented many valuable improvements therein which he is desirous from patriotic motives and considerations to cause to be appropriated and employed exclusively for the public service And whereas the said Secretary on behalf of Her Majesty's Government is willing and has proposed to negotiate with the said William George Armstrong for the purchase of the said inventions and improvements but the said William George Armstrong declined to enter into any such negotiations he being desirous and preferring to make and execute

execute an absolute deed of gift to the said Secretary in trust for Her Majesty her successors and assigns without any pecuniary or other valuable consideration whatsoever And whereas in regard to some or one of the inventions hereinbefore mentioned the said William George Armstrong has depo-ited or lodged specifications with the view of obtaining Letters Patent which have not yet been granted (as appears by the schedule hereunder written) Now this Indenture witnesseth that for the purpose of effectuating the aforesaid desire and intention of the said William George Armstrong and in consideration of the premises he the said William George Armstrong doth by these presents grant bargain assign and transfer unto the said Secretary his successors and assigns the full and whole benefit and advantage of all and singular the inventions and improvements in the manufacture of ordnance fire-arms and other matters and things specified in the schedule hereunder written and of all Letters Patent which have been already taken out and obtained or may hereafter be taken out and obtained in respect of the said inventions and improvements or any of them and all the right title interest property benefit claim and demand whatsoever both at law and in equity of him the said William George Armstrong into out of or upon the said inventions and premises To have hold receive and take the said inventions and premises hereby assigned or intended so to be unto the said Secretary his successors and assigns on the behalf and for the benefit of the Queen's Most Excellent Majesty her successors and assigns and to the intent that the same may be appropriated and devoted to the public service and to or for no other intent or purpose whatsoever And the said William George Armstrong for himself his heirs executors and administrators doth hereby covenant with the said Secretary his successors and assigns on behalf of Her Majesty her successors and assigns that he the said William George Armstrong and his executors or administrators will from time to time and at all times hereafter on the request and at the cost of the said Secretary for the time being make do and execute or cause and procure to be made done and executed every such further assignment assurance act deed matter and thing whatsoever for the more effectually assigning and assuring the said inventions and premises expressed to be hereby assigned unto the said Secretary for the time being his successors and assigns for the purpose and in the manner aforesaid according to the true intent and meaning of these presents as by the said Secretary for the time being or his successors or assigns or his or their counsel in the law shall be reasonably advised or required In witness whereof the said parties to these presents have hereunto set their hands and seals the day and year first above written.

The SCHEDULE above referred to.

1st. The breech-loading wrought iron rifled gun.	Provisional specification, dated 11 February 1857. Dropped before final specification. This provisional specification describes the method of loading at the breech. It also refers to a mode of construction which was never adopted. The mode of manufacturing ultimately adopted, and which forms an essential peculiarity of these guns, constitutes the subject of a provisional specification, dated 15th November 1858, and which has now four months to run.
2d. The projectile, available at option as shot, shell, or canister.	No patent has been taken for this, but it is still open to Mr. Armstrong to secure one.
3d. The time fuze and percussion fuze.	A complete patent (dated 10th April 1858) has been obtained for these fuzes.
4th. The percussion shell for naval use and siege operations.	No patent taken, but nothing to prevent the obtaining of one.
5th. The pivot carriage for field artillery.	The same.
6th. The recoil and traversing carriage for bearing ordnance.	The same.
7th. The tangent sight with vernier movements for vertical and lateral adjustment.	The same.
8th. The nyctoscope or instrument for maintaining a fire upon a fixed object at night or in a fog.	Provisionally specified under the 22d July 1857, but dropped before final specification.

W. G. Armstrong. (L.S.)

Signed, sealed, and delivered by the above-named William George Armstrong, in the presence of

Cha. M. Clode, Solicitor to War Department.

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THIS INDENTURE made the 16th day of January in the year of our Lord 1859 between Her Majesty's Principal Secretary of State for the War Department of the first part *Sir William George Armstrong* of Newcastle-upon-Tyne Knight of the second part and *George Cruddas* of the same place engine manufacturer *Richard Lambert* also of the same place engine manufacturer and *George Wightwick Rendel* of Hyde Park-street in the county of Middlesex civil engineer of the third part Whereas by an Indenture bearing date on or about the 15th day of January 1859 and made between the said Sir William George Armstrong of the one part and Her Majesty's Principal Secretary of State for the War Department of the other part for the considerations therein mentioned the said Sir William George Armstrong did grant bargain assign and transfer unto the said Secretary his successors and assigns the full and whole benefit and advantage of all and singular the inventions and improvements in the manufacture of ordnance fire-arms and other matters and things specified in the Schedules thereunder written and of all Letters Patent which had been then already taken out and obtained or might thereafter be taken out and obtained in respect of the said inventions and improvements or any of them To hold and take the same unto the said Secretary his successors and assigns on the behalf and for the benefit of the Queen's Most Excellent Majesty her successors and assigns and to the intent that the same might be appropriated and devoted to the public service, and to or for no other intent or purpose whatsoever And whereas the said Principal Secretary of State for the War Department hath agreed that the said inventions assigned by the hereinbefore recited Indenture should be exclusively appropriated to the public service and should be used in the manufacture of ordnance and fire arms in the Royal Arsenal only and that it should not be lawful for the said Secretary for the time being without the consent in writing of the said Sir William George Armstrong his executors or administrators to authorise or permit any person or persons whomsoever to use the same at any other place or for any other purpose whatsoever And whereas at the request of the said Principal Secretary of State for the War Department and of the said Sir William George Armstrong and with a view and for the purpose of manufacturing ordnance fire-arms and other matters and things under and in pursuance of the inventions and patents assigned by the hereinbefore recited Indenture the said George Cruddas Richard Lambert and George Wightwick Rendel have recently erected or are now erecting and may hereafter erect on land now or hereafter to be acquired and complete considerable works and machinery with all necessary plant and appurtenances at Elswick in the borough of Newcastle-upon-Tyne aforesaid at the estimated cost of 50,000*l.* sterling, which the said Principal Secretary doth hereby assent and agree to And whereas the said Principal Secretary of State for the War Department has with the consent of the said Sir William George Armstrong testified by his execution hereof offered to the said George Cruddas Richard Lambert and George Wightwick Rendel the contract for the manufacture at the said works under or in pursuance of the said inventions and patents of the said Sir William George Armstrong of such guns as the Principal Secretary of State for the War Department for the time being may from time to time require and the said George Cruddas Richard Lambert and George Wightwick Rendel have agreed (unless prevented by some unforeseen and inevitable accident) to manufacture complete and deliver the said guns that may be so required subject to the terms and conditions hereinafter mentioned. And the said George Cruddas Richard Lambert and George Wightwick Rendel and the said Principal Secretary of State for the War Department have agreed to enter into the covenants on their parts respectively hereinafter contained Now this Indenture witnesseth that in pursuance of the hereinbefore recited agreement and in consideration of the covenants on the part of the said Principal Secretary of State for the War Department hereinafter contained the said George Cruddas Richard Lambert and George Wightwick Rendel do hereby for themselves their heirs executors and administrators jointly and each of them doth for himself his heirs executors and administrators separately covenant with the said Principal Secretary of State for the War Department and his successors in manner following that is to say that they the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators will and shall (unless prevented by some unforeseen and inevitable accident) in a proper effectual and workmanlike manner manufacture or cause to be manufactured according to and in pursuance of the said inventions and patents and under the direction of the said Sir William George Armstrong or such other person as shall be for that purpose nominated by the said Secretary and subject to the inspection and approval of the said Secretary or his authorized agent all and every of the guns which shall from time to time be required by the Principal Secretary of State for the War Department for the time being to be indicated by a notice in writing under his hand to be delivered to the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators and will and shall deliver the said guns when completed to the said Principal Secretary of State for the War Department for the time being when and where he shall direct at a fair and reasonable price to be determined as hereinafter mentioned for the metal and manufacture of the said guns exclusively of the said patents and inventions (which have been assigned to the said Secretary in trust as aforesaid) and exclusive of the cost and expenses incurred by the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators in or about all or any trials or experiments to be made during the making and manufacture of the said guns or any of them or after the completion thereof with respect either to the metal or machinery or work used in such manufacture which last-mentioned costs and expenses the said Principal Secretary of State for the War Department for the time being is to pay and discharge as hereinafter mentioned And also that it shall be lawful for the said Principal Secretary of State for the War Department for the time being by a notice in writing under his hand to the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators to countermand any order which may have been given for the manufacture of any guns at any time before the execution hereof And also

that

that the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators will and shall from time to time and at all times conduct the manufacture of the said guns under the said works shall at all times be open to the inspection of such person or persons as the Principal Secretary of State for the War Department for the time being shall from time to time for that purpose appoint if he shall consider such inspection necessary And also that the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators will and shall from time to time furnish and render to the Principal Secretary of State for the War Department a true and particular account of all monies expended by them or him from time to time in erecting or adapting the works and machinery and plant for the special purposes of manufacturing guns and other things in pursuance of the said inventions and patents And further that the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators will not and shall not at any time or times suffer or permit any person or persons not regularly and properly employed by them or him in the said works and manufacture of guns to enter the said works for the purpose of inspecting or examining the said works and machinery and for any other purpose in connexion therewith or having a relation thereto without the sanction and permission in writing under the hands of the Principal Secretary of State for the War Department for the time being or Her Majesty's engineer for the department of rifled ordnance for the time being And also that the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators will not and shall not at any time or times during the continuance of these presents disclose or make known or authorise or permit any person or persons employed by them or him to disclose or make known to any person or persons whomsoever (other than such as may be necessarily employed by them or him in the said works and manufacture of guns) the said inventions improvements and patents assigned by the hereinbefore recited Indenture or any of them or any part thereof respectively without the express sanction and permission in writing of the Principal Secretary of State for the War Department for the time being And also that the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators will not and shall not during the continuance of these presents disclose or make known to any person or persons from time to time employed by them or him in the said works and manufacture of guns as aforesaid any more of the said inventions improvements and patents or any of them than shall be necessary to enable the person or persons so employed efficiently and properly to conduct and carry on and complete the manufacture of the said guns in pursuance of the said inventions improvements and patents And also that they the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators will not or shall not at any time or times manufacture or permit or suffer to be manufactured at the said works or elsewhere any ordnance fire arms or other matters or things in pursuance of and according to the said inventions improvements and patents or any of them for any person or persons whomsoever or for any purpose whatsoever without the express sanction permission and direction in writing of the Principal Secretary of State for the War Department for the time being on behalf of Her Majesty and for the public service And further that if the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators shall at any time or times manufacture or cause to be manufactured any ordnance fire arms or other matters or things contrary to the covenant lastly hereinbefore contained then that they or he shall immediately thereupon well and truly pay or cause to be paid to the Principal Secretary of State for the War Department for the time being the sum of 5,000*l.* as and for liquidated damages and not by way of penalty And further that in case any person or persons other than the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators shall become interested in this present contract or in the said works and premises as their or his co-partner or co-partners or otherwise (except as mortgagees) they the said covenanting parties or some or one of them or their or his executors or administrators shall and will cause and procure such person or persons to enter into a covenant to observe and perform all the covenants and stipulations hereby made with the said Principal Secretary of State for the War Department for the time being and in case the said covenanting parties or any or either of them shall be desirous of borrowing money on the security of this present contract or of the said works or premises for the purpose of enabling them to perform and complete the said contract they will in the first instance apply to the said Principal Secretary of State for the War Department for such loan and will not negotiate with any other party for the same until such application shall have been refused it being the special design and object of the stipulation to avoid as much as possible the introduction of any strangers into the transactions connected with the present contract in order that the risk of the disclosure of the said inventions may not be unnecessarily incurred And the said Principal Secretary of State for the War Department for himself and his successors doth hereby covenant with the said George Cruddas Richard Lambert and George Wightwick Rendel their executors and administrators in manner following (that is to say) that the Principal Secretary of State for the War Department for the time being will and shall pay or cause to be paid to the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators a fair and reasonable price for the several guns which shall be required by the said Secretary by a notice in writing and shall be manufactured and delivered as hereinbefore mentioned (exclusive of the value of the said inventions and patents and exclusive of the costs of all trials and experiments as hereinbefore mentioned) such guns when delivered to be approved of and passed by the said Principal Secretary of State for the War Department or his duly authorised agent and such fair and reasonable price to be agreed upon between the said Principal Secretary of State for the War Department for the time being and the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators

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or failing and in default of such agreement to be determined and awarded by Her Majesty's Attorney General for the time being and such price in either case to be paid within one calendar month after the delivery of each lot or parcel of the said guns respectively by the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators to or according to the direction of the said Principal Secretary of State for the War Department for the time being And also that the Principal Secretary of State for the War Department for the time being will and shall pay and discharge the costs and expenses incurred by the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators in or about all trials and experiments made with the sanction and consent in writing of the said Principal Secretary or his successors for the purpose of proving testing or otherwise trying the said guns after the completion thereof and in or about all trials and experiments in the course or process of the manufacture of such guns respectively the amount of such costs and expenses to be agreed upon between the said Principal Secretary of State for the War Department for the time being and the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators and failing or in default of such agreement to be determined and awarded by Her Majesty's Attorney General for the time being And also that if the Principal Secretary of State for the War Department for the time being shall at any time hereafter countermand any order after the same shall have been commenced and prosecuted or abstain from giving or cease to give orders to the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators sufficient to keep the works erected and to be erected as aforesaid in full and adequate employment or if any act matter or thing shall during the continuance of these presents be done or permitted omitted or suffered by or on the part of Her Majesty's Government or the Principal Secretary of State for the War Department for the time being by reason or means whereof the said works machinery and plant erected and to be erected as aforesaid or any part thereof respectively shall be rendered wholly or partially unproductive then, and in either of such cases the Principal Secretary of State for the War Department for the time being will or shall pay or cause to be paid unto the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators a fair and equivalent compensation in money for the loss sustained by reason of such notice of countermand or as the case may be for the expenditure already made or to be made in acquiring lands and hereditaments and in erecting the said works machinery and plant as aforesaid so far as the same works machinery and plant or any part thereof respectively shall have become wholly or partially unproductive from the cause and in the manner aforesaid, and so far as the expenditure on such works machinery and plant shall have been from time to time sanctioned in writing by the said Principal Secretary of State for the War Department for the time being the amount of such compensation to be settled and agreed upon by and between the Principal Secretary of State for the War Department for the time being and the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators or failing and in default of such agreement then by two duly qualified valuers one to be named by the said Principal Secretary of State for the War Department and the other by the said George Cruddas Richard Lambert and George Wightwick Rendel or the survivors or survivor of them his executors or administrators or (in case of difference between such valuers by an umpire to be nominated by the said valuers) before they proceed to their valuation and upon the payment of such compensation these presents and every clause matter and thing herein contained shall cease and determine but subject and without prejudice to any right of action which may have previously accrued for breach of covenant And lastly it is hereby agreed and declared by and between the said parties hereto that if any question or dispute shall arise respecting the construction or meaning of any stipulation or clause herein contained the same shall be referred to Her Majesty's Attorney-General for the time being whose opinion thereon shall be conclusive and who shall have power to determine by whom the costs attending such reference shall be paid In witness whereof the said parties to these presents have hereunto set their hands and seals the day and year first above written.

Jonathan Peel (L. S.)
W. G. Armstrong (L. S.)
George Cruddas (L. S.)
Richard Lambert (L. S.)
George Wightwick Rendel (L. S.)

Signed sealed and delivered by Her Majesty's Principal Secretary of State for the War Department in the presence of

Chas. M. Clode
Solicitor to the War Department.

Signed sealed and delivered by the within-named Sir William George Armstrong and George Wightwick Rendel in the presence of

Stuart Rendel
Of 15 Devonshire Terrace
Hyde Park London.

Signed sealed and delivered by the within-named George Cruddas in the presence of

William Donaldson Cruddas
Elswick Dure House
Newcastle upon Tyne.

Signed sealed and delivered by the within-named Richard Lambert in the presence of

George Boyd
Denham Court Farm Uxbridge.

I, The Right Honourable Jonathan Peel Her Majesty's Principal Secretary of State for the War Department hereby sanction the expenditure of a sum not exceeding 10,000 *l.* on works mentioned and referred to in Sir William George Armstrong's letter of the 18th day of April 1859 Dated this 20th day of April 1859.

J. Peel.

Witness, *Chas. M. Clode.*

I, The Right Honourable Sidney Herbert Her Majesty's Principal Secretary of State for the War Department hereby sanction the expenditure of a sum not exceeding 25,000 *l.* on works mentioned and referred to in Sir William George Armstrong's letter of the 19th day of October 1859 Dated this 24th day of October 1859.

S. Herbert.

Witness, *Chas. M. Clode.*

— No. 2. —

App. No. 48.

APPOINTMENT of *Thomas Elliot Harrison*, Esq., as Valuer.

WHEREAS by an Indenture bearing date on or about the 16th day of January 1859 and made between Her Majesty's Principal Secretary of State for the War Department of the first part Sir *William George Armstrong* of Newcastle-upon-Tyne Knight of the second part and *George Cruddas* of the same place engine-manufacturer *Richard Lambert* also of the same place engine-manufacturer and *George Wightwick Rendel* of Hyde Park-street in the county of Middlesex civil engineer of the third part After reciting amongst other things that at the request of the said Principal Secretary and of the said Sir William George Armstrong and with a view and for the purpose of manufacturing ordnance fire-arms and other matters and things under and in pursuance of the inventions and patents assigned to the said Principal Secretary by the said Sir William George Armstrong the said George Cruddas Richard Lambert and George Wightwick Rendel had recently erected or were then erecting and might thereafter erect on land then or thereafter to be acquired and complete considerable works and machinery with all necessary plant and appurtenances at Elswick aforesaid at the estimated cost of 50,000 *l.* sterling which the said Principal Secretary did thereby assent and agree to And that the said Principal Secretary had with the consent of the said Sir William George Armstrong testified by his execution thereof offered to the said George Cruddas Richard Lambert and George Wightwick Rendel the contract for the manufacture at the said works under or in pursuance of the said inventions and patents of such guns as the Principal Secretary for the time being might from time to time require and the said George Cruddas Richard Lambert and George Wightwick Rendel had agreed to manufacture complete and deliver the said guns that might be so required subject to the terms and conditions thereinafter mentioned It was by the said indenture witnessed and the said Principal Secretary for himself and his successor did covenant with the said George Cruddas Richard Lambert and George Wightwick Rendel (*inter alia*) that if the said Principal Secretary for the time being should at any time thereafter countermand any order after the same should have been commenced and prosecuted or abstain from giving or cease to give orders to the said George Cruddas Richard Lambert and George Wightwick Rendel sufficient to keep the works erected or to be erected as aforesaid in full and adequate employment or if any act matter or thing should during the continuance of those presents be done or permitted omitted or suffered by or on the part of Her Majesty's Government or the said Principal Secretary for the time being by reason or means whereof the said works machinery and plant erected and to be erected as aforesaid or any part thereof respectively should be rendered wholly or partially unproductive Then and in either of such cases the said Principal Secretary for the time being would or should pay or cause to be paid unto the said George Cruddas Richard Lambert and George Wightwick Rendel a fair and equivalent compensation in money for the loss sustained by reason of such notice of countermand or as the case might be for the expenditure already made or to be made in acquiring lands and hereditaments and in erecting the said works machinery and plant as aforesaid so far as the same works machinery and plant or any part thereof respectively should have become wholly or partially unproductive from the case and in the manner aforesaid and so far as the expenditure on such works machinery and plant should have been from time to time sanctioned in writing by the said Principal Secretary for the time being the amount of such compensation to be settled and agreed upon by and between the said Principal Secretary and the said George Cruddas Richard Lambert and George Wightwick Rendel or failing and in default of such agreement then by two duly qualified valuers one to be named by the said Principal Secretary and the other by the said George Cruddas Richard Lambert and George Wightwick Rendel or in case of difference between such valuers by an umpire to be nominated by the said valuers before they proceed to their valuation And whereas since the date of such last-mentioned indenture the said Principal Secretary hath sanctioned in writing an expenditure on such works machinery and plant amounting in the whole to the principal sum of 35,000 *l.* And whereas the said George Cruddas Richard Lambert and George Wightwick Rendel have given notice that the said works machinery and plant have ceased to be adequately employed and have become from that cause partially unproductive And whereas the said Principal Secretary of State has apprised the said George Cruddas Richard Lambert and George Wightwick Rendel of his intention to terminate immediately the said contract for the manufacture of ordnance fire-arms and other matters and things under the said inventions improvements and patents Now we the said George Cruddas Richard Lambert and George Wightwick Rendel do hereby appoint you Thomas Elliot Harrison of 27 Great George-street Westminster civil engineer to settle and agree on our behalf the amount to be paid as a fair and equivalent compensation in money to us the said George Cruddas Richard Lambert and George Wightwick Rendel under the terms of the said indenture or failing and in default of such agreement than we appoint you to act as valuer on our behalf and to nominate an umpire under the terms of the said indenture In witness whereof we have set our hands this 27th day of February 1863.

George Cruddas.
Richard Lambert.

Witness to the signing hereof by the said George Cruddas and Richard Lambert

Anderson Phalp.

G. W. Rendel.

Witness to the signing of the within-named G. W. Rendel

Thomas A. Rycroft.

NOTE.—Mr. Fenton was appointed by the Secretary of State under a similar Instrument, which is held by the Elswick Ordnance Company.

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— No. 3. —

We the undersigned, Thomas Elliott Harrison, of 27, Great George-street, Westminster, civil engineer, and James Fenton, of Low Moor, in the county of York, civil engineer, the valuers appointed in the matter of the valuation particularly mentioned or referred to in the appointment hereunto annexed, do, by this writing under our hands, before proceeding in our valuation, appoint James Nasmyth, of Penshurst, in the county of Kent, engineer, to be the Umpire to decide on any matters on which we shall differ in or about such valuation.

Dated this 28th day of February 1863.

Thos. E. Harrison.
James Fenton

Witness to the signing hereof by the said Thomas Elliott Harrison and James Fenton,
William Hill.

— No. 4. —

[These Schedules were received at the War Office on the 3d April 1863.]

SCHEDULES.

(1.)

LIST of Machines in Nos. 1, 2, 4, and 11 Shops.

No. of Machine.	Description of Machine.	Maker.	Date.	Invoice Price. £. s. d.	Value for a General Manufacturer, or for Sale. £. s. d.	
	Special Machines for Guns in No. 1 Shop:					
1	Coil-turning lathe	G. & B.	March 1859	285 – –	– –	These are convertible into three slide lathes to turn, 10 ft. long, by alterations and additions as follows: new saddles for slide rests, new screws for whole length of bed and racks, 1 back head. Cost of conversion, say 120 *l.* each, to produce 3 lathes, worth, say 250 *l.* each. Credit Government for 3 heads, 6 saddles, and other work useless, 78 *l.*
2	Ditto - ditto	,,	,,	285 – –		
3	Ditto - ditto	,,	May 1859	285 – –	390 – –	
4	Ditto - ditto	,,	,,	285 – –	78 – –	
5	Ditto - ditto	,,	June 1859	291 – –		
6	Ditto - ditto	,,	,,	291 – –		
				£.	468 – –	
8	18″ turning lathe	S. B. & T.	March 1859	370 – –	200 – –	Available, but extra saddle useless; short.
,,	,, additional saddle, 70 *l.*	,,	Oct. 1861			
9	Coil-turning lathe	G. & B.	July 1859	291 – –	153 – –	Same machine as Nos. 1 to 6.
10	Ditto - ditto	,,	,,	291 – –		
12	18″ ditto ditto	S. B. & T.	March 1859	300 – –	200 – –	Available, but short for general work; 12 ft.; same as No. 8.
14	15″ ditto ditto	,,	,,	262 – –	126 – –	Extra saddle useless; available otherwise.
	Additions, 70 *l.*	,,	Oct. 1861			
16	18″ ditto - ditto	,,	April 1859	370 – –	200 – –	Available; same as No. 8.
	Additions, 70 *l.*	,,	Oct. 1861			
17	12″ ditto - ditto	,,	Mar. 1859, and Jan. 1860.	170 – –	110 – –	,, ,,
18	12″ ditto - ditto	,,	,,	170 – –	110 – –	
21	15″ ditto - ditto	,,	Mar. 1859, and Oct. 1861.	262 – –	126 – –	,, same as No. 14.
25	Coil-boring machine	,,	April 1859	300 – –	60 – –	Special; heads and beds convertible; say 1 *s.* 5 *d.* per cwt.
26	Ditto - ditto	,,	,,	300 – –	60 – –	
27	Chuck lathe	,,	,,	270 – –	152 – –	Requires a new bed (50 *l.*) to make it generally useful.
28	Double-facing machine for coils	G. & B.	June 1859	450 – –	40 – –	Special; weight, 11 tons 7 cwt., at 3*l.* 10*s.*
29	,, coil-boring machine	P. F. Co.	April 1859	375 – –	120 – –	Might be converted into lathes, worth 250 *l.* each, at expense of, say, 130 *l.* each.
30	Ditto - ditto	,,	,,	375 – –	120 – –	
31	Quadruple coil-boring machine	,,	June 1859	550 – –	99 – –	Entirely special; weight about 33 tons.
32	Ditto - ditto	,,	Aug. 1859	550 – –		
33	Ditto - ditto	,,	Sept. 1859	550 – –		
74	Chuck lathe for trunnions	S. B. & I.	Nov. 1859	158 7 –	85 – –	Require new beds, same as for No. 27; range of slides small, only 22 inches; otherwise available.
87	Ditto - ditto	,,	,,	158 7 –	85 – –	
104	Vertical boring machine	P. F. & Co.	Dec. 1859 and Jan. 1860.	321 5 –	70 – –	Entirely special; heads have hollow mandrils; frames useless; range only 4 feet; weight, about 14 tons.
104½	Ditto - ditto	,,	,,	321 5 –		
126	Trunnion-turning machine	S. B. & I.	Oct. 1859	327 – –	45 – –	Special; 2 heads might be converted for lathes.
127	20″ stroke-shaping ditto	P. F. & Co.	Nov. 1859	230 6 3	100 – –	Can be made general shaping machines, at a cost of about 95 *l.*
128	Ditto - ditto	,,	Oct. 1859	230 6 3	100 – –	
129	15″ turning lathe	S. B. & I.	Nov. 1859	180 – –	115 – –	
130	Ditto - ditto	,,	,,	180 – –	115 – –	

List of Machines in in Nos. 1, 2, 4, and 11 Shops—*continued.*

No. of Machine.	Description of Machine.	Maker.	Date.	Invoice Price. £. s. d.	Value for a General Manufacturer, or for Sale. £. s. d.	
	Special Machines for Guns, &c.—*continued.*					
217	Quadruple-boring machine -	P. F. & Co.	Mar. 1860: 1,159 *l.* 10 *s.*	308 - -		
		S. B. & I.	35 *l.*			
218	Ditto - ditto - - -	„	April 1860 35 *l.*	308 - -	100 - -	Entirely special; weight, about 30 tons.
		P. F. & Co.	July 1860 2 *l.* 10 *s.*			
219	Ditto - ditto - - -	„	- - -	308 - -		
220	Ditto - ditto - - -	„	- - -	308 - -		
270	Double-boring ditto - -	„	June 1860	295 - -	70 - -	Same as 104 and 104½; weight, 14 tons.
270½	Ditto - ditto - - -	„	„	295 - -		
	Spare chuck for trunnion operations.	S. B. & I.	28 Nov. 1859	17 - -	1 7 -	Useless; weight, 9 cwt.
		Totals - - - £.		11,873 16 6	3,230 7 -	
	In No. 2 Shop:					
7	Rifling machine - - -	S. B. & I.	April and May 1859.	234 9 2	100 - -	Entirely special; weight, about 23 tons; beds worth, say, 30 *l.* each.
11	Ditto - - - -	„	„	234 10 -		
277	Ditto - - - -	„	Feb. 1860	335 3 3		
273	Machine for screwing breech screws.	G. & B.	May and June 1860.	349 10 -		Entirely special - - -
274	Ditto - turning ditto -	S. B. & I. G. & G. B.	Jan. and May 1860.	297 - -		Special head, convertible for 16″ lathe.
34	Ditto - screwing ditto -	G. & B. & F. & Co.	July and Dec. 1859; Jan. 1860.	207 5 -	155 - -	Entirely special - - - Weight, 31 tons nearly.
15	Ditto - „ breech ends	S. B. & I. F. & Co.	June 1859 and Jan. 1860.	269 10 -		Entirely special - - -
19	Ditto - „ ditto - -	„	„	269 10 -		Entirely special - - -
81 & 84	4 boring machines in pit (south side), 390 *l.* each.	F. & Co.	Aug. 1859 to Jan. 1860.	1,560 - -	140 - -	Not suitable for general work; beds convertible for lathes, say 30 *l.* each.
188	Horizontal drilling machine -	„	Feb. 1860	50 8 -	10 - -	Special.
189	Ditto - ditto - - -	„	„	50 8 -		
90	Ryming machine - - -	„	„	46 4 -	12 - -	Special, but convertible.
57	Drilling ditto - - -	S. B. & F.	Nov. 1859	45 - -	22 10 -	Available; all these machines much deteriorated by heavy piece-work.
115	Shaping ditto - - -	„	Dec. 1859	50 - -	25 - -	
116	Ditto - - - -	„	- - -	50 - -	25 - -	
20	Chambering ditto - - -	„	June 1859	170 - -	25 - -	Special; heads partly convertible for 18″ lathes.
91	Breech and boring machine -	„	Jan. 1860	323 5 -	25 - -	
78	Ditto - ditto - -	„	- - -	301 5 9	120 - -	Convertible into lathe for light work; gear lights, no back head.
61	12″ face lathe - - -	„	Sept. 1859	114 - -	57 - -	Available for same description of work.
62	12″ ditto - - - -	„	- - -	114 - -	57 - -	
63	12″ ditto - - - -	„	- - -	114 - -	57 - -	
64	12″ ditto - - - -	„	Nov. 1859	114 - -	57 - -	
	Chucks for machines, viz.:					
	Vent-pieces - - -	„	15 Nov. 1859	42 - -	- - -	Special weight, say four tons.
	Ditto - - - -	„	18 Nov. 1859	10 - -	- - -	
	Levers - - - -	„	15 Nov. 1859	30 10 -	- - -	
	Ditto - - - -	„	1 Dec. 1859	9 10 -	- - -	
	Ditto - - - -	„	5 Jan. 1860	37 - -	- - -	
	Ditto - - - -	„	14 Jan. 1860	22 - -	- - -	
	Keep pins - - -	„	25 Jan. 1860	12 10 -	- - -	
	Vent-pieces - - -	„	7 Feb. 1860	24 - -	12 - -	
				5,486 18 2	899 10 -	
352	Machine for scoring guns -	S. B. & T. & W. G. A. & Co.	September and Dec. 1861.	220 8 -	110 - -	Available for ordinary work, by additions.
		Totals - - £.		5,707 6 2	1,009 10 -	
	In Coiling Shop No. 11.					
6 F.	5 C hammer (steam) (D. B. 8.)	K. F. & Co.	June 1859	184 13 -	123 - -	
7 „	3 C ditto - (D. B. 40.)	„	Dec. 1859	156 9 -	105 - -	
8 „	Tilt hammer - - - -	F. & Co.	„	37 2 6	- - -	Special, for hammering copper facings.
173 „	Drilling machine (C. L. No. 1. 352.)	W. G. A. & Co.	Feb. 1860	47 - -	23 10 -	Available for rough drilling.
D. B. 188	Coiling machine (in coiling shop not erected.)	„	Aug. 1860	300 - -	—	
D. B. 187	Coiling machine (in field, not erected, including mandrils.)	„	„	674 13 -	45 - -	Entirely special; weight, say 15 tons.
D. B. 185	Hydraulic press and pumps -	„	„	281 11 6	70 - -	May be found available for some purpose.
		Totals - - £.		1,681 9 -	366 10 -	

List of Machines in Nos. 1, 2, 4, and 11 Shops—*continued.*

No. of Machine.	Description of Machine.	Maker.	Date.	Invoice Price.	Value for a General Manufacture, or for Sale.	
	Machines in West-end of Forge Shop No. 4.			£. s. d.	£. s. d.	
1 F.	35-cwt. steam hammer (D.B. 1.)	R. M. & Co.	Nov. 1858	562 2 6	377 – –	Available.
2 „	Small ditto - (D.B. 7.)	G. & R.	Mar. 1859	127 – –	63 10 –	Ditto.
	3 welding rams - (D.B. 185.) 1 ditto (lying outside pr. office.)	W. G. A. & Co.	Aug. 1860	270 4 –	20 4 7	Useless.
3 „	60-cwt. steam hammer (D.B. 16.)	R. M. & Co.	July 1859	1,356 1 –	904 – –	Available.
	Hammer-head and anvil for ditto (D.B. 153)	„	Dec. 1859	178 8 –	89 4 –	Ditto.
			£.	2,493 15 6	1,453 18 7	
	Shrinking apparatus, including hoist and crane.	W. G. & Co.	- - £.	568 16 7	100 – –	Special crane, convertible for general work.

(2)

Shot and Shell Machines in No. 12 Shop.

No. of Machine.	Description of Machine.	Maker.	Date.	Invoice Price.	Value for a General Manufacture, or for Sale.	
				£. s. d.	£. s. d.	
38	Shell-boring machine - -	G. & B.	August 1859 - add 42 *l.*	162 – –	- - -	The whole of the machines in this Schedule, excepting those noted as available, are specially designed for the manufacture of shot and shell, and could not be converted for other purposes at a cost which would make it worth while for any one to undertake their conversion. It is assumed that the heads of the turning and grooving lathes, of which there are 39 in all, might be gradually absorbed in the manufacture of small slide-lathes for general work, and that the horizontal tapping machines, of which there are six, might be converted, at a cost of about 30 *l.*, for screwing small nuts. The weight of all the machines in this Schedule is 92 tons 16 cwt., which we have allowed for at 7 *l.* 10 *s.*, or about four times their value for breaking up.
39	Ditto - ditto - -	„	August 1859 - add 42 *l.*	162 – –	—	
40	Shell-turning machine - -	„	September 1859 add 22 *l.*	152 – –	—	
41	Ditto - ditto - -	„	September 1859 add 22 *l.*	152 – –	—	
42	Shell-grooving machine - -	„	September 1859 add 7 *l.* 7 *s.* 6 *d.*	132 7 6	—	
43	Ditto - ditto - -	„	September 1859 add 7 *l.* 7 *s.* 6 *d.*	132 7 6	—	
44	Plug-turning machine - -	„	October 1859 - add 14 *s.* 8 *d.*	105 14 8	—	
44½	Ditto - ditto - -	„	October 1859 - add 14 *s.* 8 *d.*	105 14 8	—	
51	Tapping machine - - -	„	October 1859 - add 1 *l.* 16 *s.*	61 16 –	—	
52	Shell and drilling machine -	„	October 1859 -	45 – –	—	
69	Shell-boring machine - -	„	January 1860 - add 42 *l.*	167 – –	—	
70	Ditto turning machine -	„	January 1860 - add 22 *l.*	152 – –	—	
71	Ditto - ditto - -	„	January 1860 - add 22 *l.*	152 – –	—	
88	Ditto grooving machine -	„	January 1860 - add 7 *l.* 7 *s.* 6 *d.*	132 7 6	—	
89	Ditto - ditto - -	„	January 1860 - add 7 *l.* 7 *s.* 6 *d.*	132 7 6	—	
90	Ditto tapping machine -	„	January 1860 - add 1 *l.* 16 *s.*	61 16 –	—	
109	Ditto - ditto - -	„	January 1860 - add 1 *l.* 16 *s.*	61 16 –	—	
131	Ditto - ditto - -	„	January 1860 - add 1 *l.* 16 *s.*	61 16 –	—	
132	Ditto leading lathe machine	„	November 1859 add 2 *l.* 18 *s.* 6 *d.*	77 18 6	—	
174	Ditto boring machine - -	„	January 1860 - add 52 *l.*	177 – –	—	
175	Ditto turning machine -	„	January 1860 - add 22 *l.*	152 – –	—	

SHOT and SHELL MACHINES in No. 12 Shop—*continued.*

No. of Machine.	Description of Machine.	Maker.	Date.	Invoice Price.	Value for a General Manufacture, or for Sale.	
				£. s. d.	£. s. d.	
176	Shell-turning machine - -	G. & B.	January 1860 - add 22 *l.*	152 – –	—	
177	Ditto grooving machine -	,,	Janury 1860 - - add 7 *l.* 7 *s.* 6 *d.*	132 7 6	—	
178	Ditto - ditto - -	,,	January 1860 - add 7 *l.* 7 *s.* 6 *d.*	132 7 6	—	
179	Ditto boring machine - -	,,	January 1860 - add 52 *l.*	177 – –	—	
180	Ditto turning machine -	,,	January 1860 - add 22 *l.*	152 – –	—	
181	Ditto - ditto - -	,,	January 1860 - add 22 *l.*	152 – –	—	
182	Ditto grooving machine -	,,	January 1860 - add 9 *l.* 17 *s.* 6 *d.*	134 17 6	—	
183	Ditto - ditto - -	G. & B.	February 1860 add 9 *l.* 17 *s.* 6 *d.*	134 17 6	—	
194	Plug-turning machine - -	,,	February 1860 add 14 *s.* 8 *d.*	106 – 8	—	
195	Ditto - ditto - -	,,	February 1860 add 14 *s.* 8 *d.*	106 – 8	—	
196	Leading lathe for shells - -	G. & B. and B. & T.	February 1860	80 – –	—	
198	Shot-drilling machine - -	G. & B.	October 1859 45 *l.* / November 1859 19 *s.* / November 1859 22 *l.* 10 *s.*	68 9 –	—	
199	Leading lathe for shells - -	G. & B.	March 1860 -	80 – –		
200	48½″ hand lathe - - - -	S. B. & T.	January 1860 -	21 – –	21 – –	Available.
201	Ditto - - - - -	,,	,,	21 – –		
223	40-pounder shell-boring machine	G. & B.	May 1860 - add 42 *l.*	277 – –	—	
224	Ditto - tapping machine -	,,	May 1860 - add 1 *l.* 16 *s.*	86 16 –	—	
225	Ditto - - ditto - -	,,	May 1860 - add 1 *l.* 16 *s.*	86 16 –	—	
226	Lead turning machine - -	,,	May 1860 -	80 – –	—	
232	40-pounder shell-boring machine	,,	May 1860 - add 42 *l.*	277 – –	—	
233	Ditto - - ditto - -	,,	May 1860 - add 42 *l.*	277 – –	—	
255	Ditto - turning machine -	,,	May 1860 - add 22 *l.*	252 – –	—	
256	Ditto - - ditto - -	,,	May 1860 - add 22 *l.*	252 – –	—	
257	Ditto - grooving machine -	,,	May 1860 - 7 *l.* 7 *s.* 6 *d.*	237 7 6	—	
258	Ditto - - ditto - -	,,	May 1860 - 7 *l.* 7 *s.* 6 *d.*	237 7 6	—	
259	Ditto - plug-turning machine.	,,	May 1860 -	112 – –	—	
260	Ditto - - ditto - -	,,	May 1860 -	112 – –	—	
261	Ditto - shell-tapping machine.	,,	June 1860 - add 36 *l.*	96 16 –	—	
262	Ditto - - ditto - -	,,	June 1860 - add 36 *l.*	96 16 –	—	
263	Ditto shell-turning machine	,,	June 1860 - add 22 *l.*	252 – –	—	
264	Ditto - - ditto - -	,,	June 1860 - add 22 *l.*	252 – –	—	
265	Ditto - 9″ drilling machine	,,	June 1860 -	36 19 10	18 10 –	Available.
266	Ditto - 6″ - ditto -	,,	,,	28 11 3	14 – –	
271	Ditto - rabbit lathe - -	,,	,,	105 – –	—	
272	Shell-boring machine - -	,,	November 1859 add 42 *l.*	172 – –	—	
291	Shell-turning machine - -	,,	June 1860 - add 22 *l.*	252 – –	—	

SHOT and SHELL MACHINES in No. 12 Shop—*continued.*

No. of Machine.	Description of Machine.	Maker.	Date.	Invoice Price.	Value for a General Manufacture, or for Sale.	
				£. s. d.	£. s. d.	
292	Shell-grooving machine -	G. & B.	June 1860 - add 7 *l.* 7 *s.* 6 *d.*	237 7 6	—	
320	Milling machine - - -	,,	May 1860 -	35 - -	—	
343	12 and 25-pr. boring machine	,,	July 1860 - add 42 *l.*	147 10 -	—	
106	9″ turning lathe boring machine	,,	October 1859 -	94 10 -	60 - -	Available.
	IN No. 16 SHOP.					
410	Turning lathe - - -	W.G.A. & Co.	May 1860 -	35 - -	17 10 -	
411	Turning lathe - - -	,,	,,	35 - -	17 10 -	
	IN STORE.					
	1 Plugging and slotting machine	G. & B.	July 1860 -	110 - -	—	
	Stereotype plates and patterns for shot and shell.	,,	August 1859 -	165 - -	—	
	1· 8″ lathe fast headstock to screw plug.	,,	May 1860 -	28 - -	—	
					696 - -	Total weight of special machines, 92 tons, 16 cwt., at 7 *l.* 10 *s.* per ton = 696 *l.*
			£.	8,655 19 9	844 10 -	

Schedule No. 2, referred to in Agreement between the Secretary of State and the Elswick Ordnance Company, dated 29th of April 1863.

The Elswick Ordnance Company,
Per *G. W. Rendel.*

(3.)

FUZE MACHINES in Nos. 10 and 20 SHOPS.

Number of Machine.	DESCRIPTION of MACHINE.	Maker.	Date.	Invoice Price.	Value for a General Manufacture, or for Sale.	
76	Foot lathe - - - -	N. & Co.	- -	- -	- -	Available.
133	Ditto - - - -	A. K.	- -	- -	- -	Available.
135	Tube-cutting machine - -	G. & B.	—	—	—	
138	Machine for drilling fuze tube	,,	- -	- -	- -	Convertible for general valve-work.
139	Ditto - punching ,, -	,,				
141	Ditto - facing ,, -	,,				
142	Ditto - boring detonator carrier.	,,				
143	Ditto - - ditto ditto -	,,				
144	Ditto - turning ditto -	,,				
145	Ditto - - ditto - ditto -	,,				
146	Ditto - boring fuze tube pellet.	,,				
147	Ditto - - ditto - ditto	,,				
148	Ditto - turning - ditto	,,				
149	Ditto - - ditto - ditto	,,				
150	Machine press for pellet -	,,				
151	Machine for drilling holes in pellet.	,,				
152	Ditto - - ditto - ditto	,,				
153	Ditto - - ditto - ditto	,,				
154	Ditto - - ditto - ditto	,,				
156	Machine for turning burster plugs.	,,				
158	Tube-cutting machine - -	,,				
159	Machine for drilling fence fuze cap.	,,				
160	Ditto - ditto - - -	,,				
161	Machine for drilling, turning, and boring.	,,				
163	7″ turning lathe - - -	G. J.				
164	9″ head on lathe bed - -	S. B. & T.				
165	Ditto - ditto - - -	,,				
166	Ditto - ditto - - -	,,				
167	Ditto - ditto - - -	,,				
186	5″ hand lathe - - -	A. K.				

App. No. 48.

FUZE MACHINES in Nos. 10 and 20 Shops—*continued.*

Number of Machine.	DESCRIPTION of MACHINE.	Maker.	Date.	Invoice Price.	Value for a General Manufacture, or for Sale.	
187	5″ hand lathe	A. K.				
191	3″ stroke-shaping machine	P. T. & C.				
192	Morticing drilling - ditto	,,				
193	Small - ditto - ditto	,,				
202	Machine for milling fuze tube	G. & B.				
203	Screwing machine (small)	,,				
206	Machine for ryming pellets	,,				
207	Drilling machine	,,				
214	6″ hand lathe	W. M. & Co.				
215	Ditto	,,				
222	Ditto	,,				
227	Lathe for time fuze nuts	G. & B.				
228	Drilling machine	,,				
229	Ryming machine	,,				
230	Tube-facing machine	,,				
238	Bushing machine	,,				
242	Drilling machine	,,				
243	Ditto	,,				
244	Ditto	,,				
245	Ditto	,,				
246	Ditto	,,				
247	Ditto	,,				
248	Ryming machine	,,				
249	Shaping machine, 3″ stroke	P. F. & Co.	- -	- -	- -	Available.
250	Ditto - ditto	,,				
252	Fuze-turning machine	G. & B.				
253	Ditto - ditto	,,				
254	Tube-facing machine	,,				
268	Fuze-turning machine	,,				
269	Ditto - ditto	,,				
275	Ryming machine	,,				
276	Ditto - ditto	,,				
279	Turning head machine	,,				
280	Ditto - ditto	,,				
281	Ditto - ditto	,,				
282	Boring machine	,,				
283	Ditto	,,				
284	Ditto	,,				
285	Ditto	,,				
294	Turning machine	,,				
296	Ditto	,,				
297	Ditto	,,				
298	Ditto	,,				
299	Ditto	,,				
300	Ditto	,,				
303	Drilling machine	,,				
305	Boring machine	,,				
306	Ditto	,,				
317	Turning machine	,,				
322	Drilling machine	,,				
372	Screwing machine	,,				
136	Milling machine (in store, 21 Shop).	,,				
137	Ditto - ditto	,,				
140	Boring machine - ditto	,,				
155	Milling machine - ditto	,,				
204	Ditto - ditto	,,				
237	Tube cutting machine ditto	,,				
251	Ditto - ditto	,,				
267	Quadruple boring machine (in store, 21 Shop).	,,				
304	Drilling machine (in 10 Shop).	,,				
293	Boring machine	,,				
No number	Tube-cutting machine (in store, 21 Shop).	,,				
,,	Tube-milling machine (in store, 21 Shop).	,,				
	IN PATTERN SHOPS.					
	1 Machine for making wood plugs.	G. & B.				
	IN No. 20 SHOP.					
77	Composition press	G. & B.				
134	Foot lathe	A. K.				
287	Machine for turning time-fuze bodies.	G. & B.				
288	Ditto	,,				
289	Ditto	,,				
290	Ditto	,,				
293	Machine for boring time-fuze caps.	,,				
355	Pressing machine	,,				

App. No. 48.

FUZE MACHINES in Nos. 10 and 20 Shops—*continued.*

	Invoice Price.		
	£. s. d.	£. s. d.	
Machines from Greenwood and Batley -	3,418 13 6	170 – –	From examination of relative cost and weight of some of these Machines, it is calculated that they may be taken at 100 *l.* per ton, therefore the total weight equals 3,419 ÷ 100 = 34 tons 3 cwt.
Ditto from A. Kinder, Nos. 133, 134, 186, and 187.	77 10 –	38 15 –	Available as small jobbing lathes.
Ditto from Holtzapffel & Co., No. 76 -	55 10 –	35 – –	Available; good.
Ditto from Fairbairn & Co., Nos. 191, 192, 193, 249, and 250.	177 14 –	88 17 –	Available.
Ditto from Simpson, No. 163 - -	24 – –	12 – –	Available.
Ditto from Smith, Peacock, and Tannet, Nos. 164, 165, 166, and 167.	70 – –	35 – –	Available.
£.	3,823 7 6	379 12 –	

Schedule No. 3, referred to in Agreement between the Secretary of State and the Elswick Ordnance Company, dated 29th of April 1863.

The Elswick Ordnance Company,
Per *G. W. Rendel.*

(4.)

MACHINES in No. 17 BOX-MAKING SHOP.

No. of Machine.	Description of Machine.	Maker.	Date.	Invoice Price.	Value for a General Manufacture, or for Sale.	
				£. s. d.	£. s. d.	
324	Sawing machine - - -	G. & B.	Feb. 1861	60 – –	45 – –	Convertible for sawing wood for packing cases.
325	Ditto - ditto - - -	„	Feb. and April 1861.	57 15 –		
326	Planing machine - - -	„	Mar. 1861 215 *l.* April 1861 6 *l.* May 1861 1 *l.* 13 *s.*	222 13 –		
327	Ditto - ditto - - -	„	Mar. and April 1861.	221 – –		
328	Machine for drilling cord-holes	„			45 – –	Special weight about six tons, at 7*l.* 10*s.*
329	Ditto - ditto 12-pounder blocks—in field.	„				
330	Ditto - ditto staple holes	„	Mar. 1861	290 10 –		
331	Ditto - ditto fuze-box trays.	„				
333	Ditto - ditto box ends -	„	May 1860	50 – –		
323	Ditto - ditto shell holes	„	April 1861	96 4 8	—	
335	Sawing machine - - -	„	May 1861	60 – –	22 10 –	Convertible for sawing wood for packing cases.
	Eight drums for the above machines.	„	„	19 4 –	—	
			£.	1,077 6 8	112 10 –	

Schedule No. 4, referred to in Memorandum of Agreement between the Secretary of State and the Elswick Ordnance Company, dated 29th April 1863.

The Elswick Ordnance Company,
Per *G. W. Rendel.*

App. No. 48.

(5.)

Summary of Cost of Guaranteed Plant.

Being Invoiced Prices, plus per-centages for Steam Power, Erection, Shafting, Buildings, &c.

	£. s. d.	£. s. d.
Machines in No. 1 shop, as per Schedule No. 1 - - -	11,873 16 6	
Ditto - - 2 ditto - ditto 1 - - -	5,707 6 2	
Ditto - - 16 and 16 ditto - ditto 2 - - -	8,655 19 9	
Ditto - - 10 and 20 ditto - ditto 3 - - -	3,823 7 6	
Ditto - - 17 ditto - ditto 4 - - -	1,077 6 8	
	31,137 16 7	
Erection, steam power, shop cranes, shafting, &c., as per Schedule No. 6, 39½% - - - - - - - -	12,299 8 8	43,437 5 3
Machines in No. 11 shop, as per Schedule No. 1 - -	1,681 9 –	
Erection, &c., 39½% on 1,303 *l.* - - - - - - -	514 13 7	
Ditto 132% on 378 *l.* (being value of forge hammers in this shop) - - - - - - - - - -	498 19 2	2,695 1 9
Machines in No. 4 shop, as per Schedule No. 1 - - -	2,493 15 7	
Erection, &c., 132% on 2,223 *l.* (amount of forge hammers in this Schedule) - - - - - - - - -	2,934 7 2	5,428 2 9
Shrinking apparatus in No. 4 shop, including hoist and crane, as per Schedule No. 1 - - - - - - - - - - - - - -		568 16 7
		52,129 6 4
Buildings, &c., as per Schedule No. 6, 63½% - - - - - - -		33,102 2 2
	£.	85,231 8 6

(6.)

Total Expenditure of Elswick Ordnance Company in Purchase of Machines, in Carriage, Erection, and in Engines, Boilers, Cranes, Shafting, &c., up to 31 December 1862.

Machines.	Invoice Price.	Carriage.	Erection.	Engines, Boilers, Shafting, Cranes, &c.	TOTAL.
	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Shot and shell -	12,038 17 5				
Fuze - - -	4,499 14 6	1,826 5 6	4,483 16 4	18,659 9 9	87,944 15 –
Gun - - -	45,303 6 10				
Box - - -	1,133 4 8				
Shrinking apparatus	531 – 6				
Shell presses - -	248 3 –	- -	69 2 8	- - -	1,040 6 2
Cooling cisterns -	192 – –				
	63,946 6 11	1,826 5 6	4,552 19 –	18,659 9 9	88,985 1 2
		or 2·90% on invoice price.	or 7·12% on invoice price.	or 29·63% on invoice price.	
		or 39½% nearly in all.			
				Boilers, Steam Pipes, Cranes, and Erection.	
Forge hammers -	6,985 19 4	- -	- -	9,253 11 10	16,239 11 2
				or 132% on invoice price.	
				£.	105,224 12 4

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STATEMENT of whole Expenditure of Elswick Ordnance Company, under heads of Buildings and Machinery, up to 31 December 1862.

Total Cost of Buildings, Foundations, Land, &c.	Total Cost of Machines, Steam Power, Shafting, Erection, &c.
£. s. d.	£. s. d.
66,756 - -	105,089 - -
or 63½% on machinery, &c.	

(7.)

STATEMENT of DEPRECIATION on GUARANTEED PLANT.

	Guaranteed Expenditure.	Depreciation.
	£. s. d.	£. s. d.
Up to the beginnning of 1860 - -	47,653 - -	—
Ditto - ditto - 1861 - -	85,000 - -	4,765 - -
Ditto - ditto - 1862 - -	80,235 - -	8,023 - -
Ditto - ditto - 1863 - -	72,211 - -	7,221 - -
TOTAL Depreciation - - - £.		20,009 - -

(8.)

Loss by inadequate employment of SHOT, SHELL, and FUZE PLANT.

IN our detailed statement of cost of manufacture submitted to the War Office, 10th April 1862, we calculated upon 110,000 *l.* worth of work for the year, and rated interest depreciation and general expenses accordingly, as follows :—

£.		
5,340	Depreciation rate on value of work,	4·76%
3,500	Interest on capital „ „	3·06
14,200	General expenses „ „	12·92
Total - - - £.	23,040	

The amount of work actually done in the year will be 56,800 *l.*, instead of 110,000 *l.* The above rates levied on this amount of work will produce the following sums :—

		£.
Depreciation,	4·76% on 56,800 *l.* - - - -	2,703
Interest,	3·06% „ - - - -	1,738
General charges,	12·92% „ - - - -	7,338
	Total - - -	£. 11,779

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But the Charges actually required are as follows:—

	£.
Depreciation, same as above	5,340
Interest	3,500
General charges, say three-fourths of above	10,650
Total	£. 19,490

to meet which only 11,779 *l.* is raised, leaving a deficiency of 7,711 *l.*

Add loss of Profit as follows:—

	£.
Amount of orders assumed	110,000
Amount actually given	56,800
Difference	£. 53,200
Profit on 53,200 *l.* at 7·8%	£. 4,149
Total loss, 7,711 *l.* + 4,149 *l.*	£. 11,860

In the above statement the whole plant employed is taken into account, viz., 53,400 *l.* Out of this amount 33,940 *l.* was guaranteed capital, therefore the total loss of 11,860 *l.* × 33,940 *l.* ÷ 53,400 *l.* = 7,558 *l.*, the loss under the guarantee, leaving 4,302 *l.* unrecognised loss.

(9.)

Loss by inadequate employment of Gun Plant.

1. By interest on Capital:

It is assumed that our present contracts cannot be entirely completed before the end of June.

The forge shops, No. 4 and 11, were entirely suspended on the 1st January 1863.

No. 1 shop was entirely suspended in the middle of February.

The remainder of the gun plant will be entirely suspended at the end of June.

Assuming the guaranteed amount to be paid by the end of March, the following interest will be due upon the above plant:—

Nos. 4 and 11. Value as per Schedule, No. 1, 13,088 *l.*, at 5% for three months	£. 163
No. 1. Value as per Schedule, No. 1, 20,310 *l.*, at 5% for 1½ month	127
Nos. 2, &c. Value 15,377 *l.* This plant will vary from full employment on the 1st January to total cessation on the 30th June, which is equivalent to full employment for three months	192
Interest on remaining three months, at 5%	
Total interest on Capital	£. 482

2. By General Charges:

In our detailed statement of cost of manufacture submitted to the War Office, 20th of March 1862, we showed that, with a plant of 128,000 *l.* value, adequately employed, the general charges for the year were 32,239 *l.*, or 25% nearly of the plant. Taking the same

App. No. 48. rate upon the plant employed between the 1st January and the end of June 1863, we ge the following amounts :—

	£.
No. 1. Shop. Value of plant 21,078 *l.*, employed from January to middle of February, 25% for 1½ month	658
No. 2. Value of plant, 15,377 *l.*, fully employed three months, 25%, for three months	961
Total amount raised for general charges by rate assumed in the above estimate from January to June, six months	£. 1,619

This sum is inadequate. The general charges for the months will be more nearly as in Appendix, 6,650 *l.* ; leaving 5,031 *l.* unprovided for.

TOTAL CLAIM.

	£.
1. By interest on capital	482
2. By general charges	5,031
TOTAL	£. 5,513

(10.)

APPENDIX to Schedule, No. 9.

ESTIMATE of GENERAL EXPENSES for Six Months, from 1 January to 30 June 1863.

	£. s. d.		£. s. d.
Salaries		Drawing office	
Gas rate		Cartage	
Insurance		Oils and small stores	
Water rate		Coals for boilers and offices	
Rents and Taxes		Stamps and stationery	
Foremen's wages		Repairs to buildings	
Enginemen and firemen's wages		„ machinery	
Watchmen and police, gatekeepers, and messengers.		General tools expended	
Time and storekeepers and office boys.		Files	
General labourers not specially charged.		TOTAL £.	6,650 – –

(11.)

Statement of Loss on Stores, &c., left on hand.

	Weight.					Cost.				Realizable Value.			
Gun Iron:	*Tons.*	*cwts.*	*qrs.*	*lbs.*		£.	*s.*	*d.*		£.	*s.*	*d.*	
499 bars 40-pounder iron	45	6	0	11									
240 „ 70 „ „	33	8	2	6									
91 „ 110 „ „	14	13	3	14									
309 „ 300 „ „	93	4	3	12									
12 „ 600 „ „	4	13	0	0									
40 „ 25 „ „	3	3	3	20									
14 „ 12 „ „	0	19	2	0									
26 „ EX „ „	6	16	2	0									
160 „ sundry „	30	9	2	0									
145 „ „ „	15	16	0	12									
	248	11	3	19	19*l.* per ton -	4,723	6	5	14*l.* per ton -	3,480	6	11	
Pig Iron:													
Tyne Iron, Coys Pig	340	0	0	0	62*s.* per ton -	1,054	–	–	55*s.* per ton -	969	–	–	
Ystalalyfera Coys „	210	0	0	0	78*s.* „ -	819	–	–	70*s.* „ -	735	–	–	
Furnished Shot and Shell:													
3,771 110-pounder segment shell	–	–	–		15*s.* 6*d.* each -	2,922	10	6	4*s.* 3*d.* each -	801	6	9	
500 „ „ common „	–	–	–		13*s.* 8*d.* „ -	341	13	4	3*s.* 3¼*d.* „ -	81	15	5	
519 20 „ segment „	–	–	–		4*s.* 2½*d.* „ -	109	4	1	11¼*d.* „ -	24	6	7	
997 12 „ „ „	–	–	–		2*s.* 10*d.* „ -	141	4	10	7⅜*d.* „ -	32	3	11	
233 9 „ „ „	–	–	–		2*s.* 5½*d.* „ -	28	12	9	5½*d.* „ -	5	6	9	
5 6 „ „ „	–	–	–		2*s.* 1*d.* „ -	–	10	5	3⅜*d.* „ -	–	1	6	
9 6 „ solid shot	–	–	–		1*s.* 9¼*d.* „ -	–	15	11	3½*d.* „ -	–	2	4	
3 110 „ „ „	–	–	–		11*s.* 3*d.* „ -	1	13	9	3*s.* 2*d.* „ -	–	9	6	
2 110 „ zinc ribbed shot	–	–	–		17*s.* 6*d.* „ -	1	15	–	2*s.* 3*d.* „ -	–	4	6	
1 7″ shell for howitzer	–	–	–		13*s.* 8*d.* „ -	–	13	8	3*s.* 2*d.* „ -	–	3	2	
9 40-pounder shot and shell	–	–	–		7*s.* „ -	3	3	–	1*s.* 7¼*d.* „ -	–	14	5	
5 20 „ ditto	–	–	–		4*s.* 2½*d.* „ -	1	1	–	11¼*d.* „ -	–	4	8	
6 25 „ ditto	–	–	–		– – –	1	5	3	„ „ -	–	5	8	
9 12 „ ditto	–	–	–		2*s* 10*d.* each -	1	5	6	7¾*d.* „ -	–	5	10	
300 40 „ common shell	–	–	–		7*s.* 1*d.* „ -	106	5	–	1*s.* 6*d.* „ -	22	10	–	
57 32 „ shell, zinc ribbed	–	–	–		7*s.* „ -	19	19	–	9*d.* „ -	2	2	9	
2 100 „ ditto, copper „	–	–	–		17*s.* 6*d.* „ -	1	15	–	2*s.* 3*d.* „ -	–	4	6	
463 shell plugs, gun metal (finished)	0	0	0	78½	4*d.* „ -	7	14	4	7½*d.* „ -	2	9	1	
576 ditto - ditto (castings)	0	1	0	25	10½*d.* lb. -	5	19	10	„ „ -	4	5	7	
Guns:													
1 70-pounder muzzle-loading gun	3	0	0	0	– – –	355	–	–	– – –	–	–	–	Guns exhibited at International Exhibition in the name (by order) of the Secretary of State for War.
1 70 „ breech - ditto	3	0	0	0	– – –	400	–	–	– – –	–	–	–	
Soft metal for coating projectiles (lead and tin)	26	16	0	0	4¼*d.* per lb. -	1,063	1	4	3*d.* per lb. -	750	8	–	
12 M gun wads for bursters	–	–	–		6*s.* M -	3	12	–	—	—			
3,361 feet of iron bursters, tube	1	8	3	0	6½*d.* ft. -	91	–	6	5*s.* per cwt. -	7	3	9	
Fuze metal	2	0	0	0	8*d.* per lb. -	149	6	8	6*d.* per lb. -	112	–	–	
Zinc rod 7/10″ for ribbed projectiles	1	19	0	19	26*s.* per cwt. -	50	18	5	2*d.* „ -	158	15	–	
Ditto - ½ „ ditto	6	10	3	19	„ „	170	3	11					
Regulus of antimony, about	4	0	0	0	14*l.* per ton -	164	–	–	36*l.* per ton -	144	–	–	
½″ drawn copper bolts for gun vents	0	11	1	8	1*s.* 2½*d.* per lb.	76	12	2	91*l.* „ -	51	10	3	
Copper strips for ribbed projectiles	0	1	2	18	1*s.* 3*d.* „	11	12	6	„ „ -	7	11	1	
11,097 iron plugs for 20-pounder shell (rear end.)	1	17	0	17	2¼*d.* each -	104	–	8	4*s.* per cwt. -	7	8	7	
10,866 burster plugs (castings), gun metal	0	5	3	8	1*s.* 3*d.* lb. -	40	15	–	7½*d.* lb. -	20	7	6	
1,080 - ditto (finished) - ditto	0	0	1	22	1*s.* 9*d.* „ -	4	7	6	„ - -	1	11	3	
2,888 12-pounder bursters, finished (not filled)	0	7	2	26	5*d.* each -	60	3	4	4*s.* cwt. -	1	10	11	
	0	2	1	18					7½*d.* lb. -	8	8	9	
115 20 „ burster tubes	0	0	1	16	17*s.* 6*d.* pr. 100	1	–	4	4*s.* „ -	–	1	7	
1,337 12 „ ditto - ditto	0	3	2	9	10*s.* 6*d.* „	7	–	4	„ - -	–	14	4	
Marine glue for lining shells	–	–	–		– – –	35	3	–	20% off -	28	2	5	
2,124 yards black ribbon for fuze boxes	–	–	–		1½*d.* yard -	13	5	6	—	—			
10,648 „ „ gallon - ditto	–	–	–		6*s.* 9*d.* per yard	24	19	2	—	—			
Packing Boxes (Unused).													
Pillar fuze cases				579	8*s.* 4*d.* each -	241	5	–					The fuze cases are all planed, painted, and carefully made watertight.
Concussion fuze cases				„	– – –	–	–	–					
Time „ „				275	9*s.* 7*d.* „ -	131	15	5					
6-pounder shell boxes				12	2*s.* 8*d.* „ -	1	12	–	– – –	–	–	–	The shell boxes are of the pattern used formerly for issuing the projectiles for service.
40 „ „ „				62	1*s.* 7*d.* „ -	4	18	2					
40 „ „ „				793	„ „ -	62	15	7					

	Weight.		Cost.		Realizable Value.	
Packing Boxes in use:	*Tons. cwts. qrs. lbs.*		£. s. d.			Charged according to amount of use.
Pillar fuze cases - - - - - 39	- - -	4s. 2d. each -	8 2 6			
Concussion ditto ditto - - - - 940	- - -	4s. 4d. „ -	203 13 4	- -	- -	½ of cost.
Time ditto ditto - - - - - 521	- - -	4s. 9½d. „ -	124 16 5			
40-Pounder shell boxes - - - 492	- - -	6¼d. „ -	12 16 3			
6 „ „ „ - - - 4	- - -	10⅜d. „ -	- 3 7			
110 „ „ „ segment - - 379	- - -	7½d. „ -	11 16 10			
„ „ „ „ common - - 499	- - -	11d. „ -	22 17 5			
20 „ „ „ (to hold 2 each) 294	- - -	5d. „ -	6 2 6			
„ „ „ „ („ 4 „) 93	- - -	1s. 1d. „ -	5 - 9			
12 „ „ „ - - - 59	- - -	9d. „ -	2 4 3			
40 „ „ „ (old pattern) - 374	- - -	6d. „ -	9 7 -	- -	- -	⅓ of cost.
100 „ „ „ (rough) - - 1,520	- - -	11d. „ -	69 13 4			
100 „ gun cases - - - 19	- - -	22s. 7d. „ -	21 9 1			
40 „ „ - - - - - 5	- - -	11s. 2d. „ -	2 15 10			
100 „ breech-screw cases - - 27	- - -	5s. 5d. „ -	7 6 3			
40 „ „ „ „ - - 45	- - -	3s. 9d. „ -	8 8 9			
100 „ vent-piece cases - - 34	- - -	1s. 5d. „ -	2 8 2			
Foundry Tools:						
Cast-iron core plates, shell bogie, ladle patterns, shot and shell boxes, blocks, stands, &c,	41 1 1 10	2s. 3d. per lb.	92 8 1			
Plates and fittings for machines - - -	0 10 0 2	3s. „	1 10 1			
Malleable iron segment, boxes, cores, cramps, &c.	5 12 3 22	4s. 6d. „	25 8 2			
Steel and iron pins for segment boxes, bolts and nuts, crooks, &c.	0 7 1 24	9s. „	3 7 2			
Cast-iron and wrought-iron shell bogies - -	6 13 2 0	2s. „	13 7 -			
„ 3 Grinders bogies - - -	0 7 0 0	4s. 6d. „	1 11 6			
„ 6 Box „ - - -	0 11 3 0	2s. 6d. „	1 9 5			
„ 131 Rammers and gits for shot and shell.	0 9 2 26	2s. „	- 19 5			
Tools in Nos. 10 and 20 Shops:						
Steel turning tools and chisels - - - -	0 4 2 7	17s. 6d. p' cwt.	3 19 10	- -	- -	¼ of cost.
„ Drifts, scrapers drills, shears, plyers, &c., and anvils.	0 1 2 5	20s. „	1 10 11			
„ Gauges - - - - - - -	0 1 2 7	2s. 6d. per lb.	21 17 6			
„ Taps and dies - - - - -	0 0 2 12	37s. 6d. p' cwt.	1 2 9			
„ Punches, tests, and 4 blocks for brass washers	0 0 2 6	1s. 3d. per lb. -	3 17 6			
Wrought-iron block, &c. - - - -	0 0 0 8	5s. per cwt. -	- - 4			
„ Bolts, plates, keys and anvil, and tools for tinsmith.	0 2 3 25	5s. „ -	- 14 10			
Cast-iron surface plates - - - - -	0 0 1 20	15 s. „ -	- 6 5			
2 Gauging machines for concussion fuze bodies -	- - -	5l. each - -	10 - -			
1 „ „ „ „ cap -	- - -	5l. „ - -	5 - -			
1 „ „ for pillar fuzes - - -	- - -	5l. „ - -	5 - -			
Sundry tools for time, concussion, and pillar fuzes, and bursters.	0 5 0 16	22s. 6d. p'cwt.	5 15 8			
Brass tools in No. 20 shop - - - -	0 0 1 10	7½d. per lb. -	1 18 9			
Copper „ magazine - - - -	0 0 0 24					
16 Copying presses - - - - -	- - -	40s. each -	32 - -			
3 Die „ - - - - - - -	- - -	20s. „ -	3 - -			
1 Brass „ - - - - - -	- - -	40s. „ -	2 - -			
4 Small lever „ - - - - - -	- - -	20s. „ -	4 - -			
1 Weighing machine for time fuze cap - -	- - -	5s. „ -	- 5 -			
1 Burnishing „ concussion pellet -	- - -	40s. „ -	2 - -			
1 Rolling „ tin boxes - - -	- - -	50s. „ -	2 10 -			
1 Burrowing „ „ - - -	- - -	50s. „ -	2 10 -			
2 Machines for putting wires into con. fuses -	- - -	15s. „ -	1 10 -			
1 Machine for per. fuzes - - - -	- - -	15s. „ -	- 15 -			
Tools in No. 12 Shop:						
Steel Chisels, turning tools and cutters - -	1 10 2 5	17s. 6d. p' cwt.	26 14 6			
„ Drills, callipers and drifts - - -	0 0 2 16	20s. „	- 12 10			
„ Pincers - - - - - - -	0 0 0 2½	9d. per lb. -	- 1 10			
„ Scrapers - - - - - - -	0 0 1 4	15s. per cwt.	- 4 4			
„ Templates - - - - - -	0 0 1 14	22s. 6d. „	- 8 5			
„ Paper-cutters - - - - - -	0 0 0 15	30s. „	- 4 -	- -	- -	¼ of cost.
„ Tap-screws, gauges and taps - - -	0 1 2 7	37s. 6d. „	2 18 7			
„ drivers - - - - - - -	0 1 0 24	12s. 6d. „	- 15 2			
„ Cores - - - - - - -	0 1 3 3	32s. 6d. „	2 17 9			
„ Rymers - - - - - - -	0 1 1 1½	25s. „	- 6 7			

Tools in No. 12 Shop—*continued.*	Weight. *Tons. cwts. qrs. lbs.*		Cost. £. s. d.	Realizable Value. £. s. d.	
Wrought-iron cramps, clasps, hooks, plyers, ladles, pokers, tongs, bolts and plates, cradles and scrapers.	1 0 2 19	5 *s.* per cwt. -	5 3 4		
Wrought-iron dies and moulds - - -	0 3 1 10	10 *s.* „ -	1 13 4		
„ Ring gauges - - - -	0 1 1 0	42 *s.* 6 *d.* „ -	2 13 1		
„ Foot screws - - - -	0 1 0 9	7 *s.* 6 *d.* „ -	– 8 1		
„ Drivers, forks, wrenches, clams, and keys.	0 3 1 11	6 *s.* 3 *d.* „ -	1 1 –		
Wrought-iron mandrils - - - - -	0 1 1 16	7 *s.* „ -	– 9 9		
„ Chain 3–8″ - - - -	0 2 0 25	8 *s.* „ -	– 17 9	- -	- - ¼ of cost.
Cast-iron ring gauges - - - -	0 2 1 15	37 *s.* 6 *d.* „ -	4 9 5		
„ Moulds - - - - - -	2 17 1 20	12 *s.* 6 *d.* „ -	35 17 9		
„ Press and die frames - - -	1 0 0 4	3 *s.* „ -	3 – 1		
„ Balance weights - - - -	0 6 3 0	2 *s.* „ -	– 13 6		
„ Surface plates and chucks - - -	0 5 3 15	15 *s.* „ -	4 8 3		
Brass Gauges - - - - - -	0 0 0 27	100 *s.* „ -	1 4 1		
„ Moulds - - - - - -	0 13 0 22	25 *s.* „ -	16 9 11		
„ Chucks - - - - - -	0 0 1 21	50 *s.* „ -	1 1 10		
„ Brass and iron moulds - - - -	0 0 1 9	3 *s.* per lb. -	5 11 –		
		£.	14,453 – 10	£.	7,463 3 3

	£. s. d.
	14,453 – 10
Deduct for shot and shell ordered to be completed and delivered separately - - - - - - -	2,682 – –
Total Value of Stores - - - £.	11,771 – 10

Schedule now referred to in the Memorandum of Agreement between the Secretary of State and the Elswick Ordnance Company, dated 29 April 1863.

The Elswick Ordnance Company,
per *G. W. Kendel.*

(12.)

SUMMARY of Value of Guaranteed Plant for a general Manufacture, or for Sale.

	£. s. d.
Machines in No. 1 Shop, as per Schedule No. 1 - - - - - - -	3,230 7 –
Ditto „ 2 „ ditto „ 1 - - - - - - -	1,009 10 –
Ditto „ 11 „ ditto „ 1 - - - - - - -	366 10 –
Ditto „ 12 & 16 ditto „ 2 - - - - - - -	844 10 –
Ditto „ 10 & 20 ditto „ 3 - - - - - - -	379 12 –
Ditto „ 17 „ ditto „ 4 - - - - - - -	112 10 –
Ditto „ 4 „ ditto „ 1 - - - - - - -	1,453 18 7
Shrinking Apparatus „ 4 „ ditto „ 1 - - - - - - -	100 – –
	7,496 17 7
Erection, steam power, shop cranes, shafting, &c., 39½ per cent. on 5,715 *l.*, being value of machinery out of above amount.	2,257 10 –
Erection, steam power, shop cranes, shafting, &c., 132 per cent. on 1,661 *l.*, being value of forge hammers in above amount.	2,192 10 –
	11,936 17 7
Buildings, &c., as per Schedule 6, 63½ per cent. - - - - - -	7 579 16 –
TOTAL - - - £.	19,516 13 7

App. No. 48.

(13.)

SUMMARY of CLAIMS.

	£. s. d.	£. s. d.
Cost of Guaranteed Plant, as per Schedule 5 (say) - - -	85,000 – –	
Less present value, as per Schedule 12 - - - - -	19,516 13 7	
Total Loss of Machinery - - - - - -		65,483 6 5
Loss from INADEQUATE EMPLOYMENT.		
Shot, Shell, and Fuze Department, as per Schedule 8 - -	7,558 – –	
Gun Department, as per Schedule 9 - - - - -	5,513 – –	
Loss on Stores, as per Schedule 11 - - - - -	6,989 17 7	
		20,060 17 7
TOTAL Claim - - - £.		85,544 4 –

— No. 5. —

(A.)

The Elswick Ordnance Company, and the Secretary of State for War.

Leamington, 30 March 1863.

WE agree that the amount due to the Elswick Ordnance Company is 85,544 *l.* 4*s.*, on the assumption that the Government are not entitled to claim the deduction of the sum of 20,009 *l.* on account of previous depreciation of the machinery, this question being left for further consideration; Mr. Fenton, on behalf of the Government, claiming that such sum ought to be deducted, and the amount thereby reduced to 65,535 *l.* 4*s.*; and Mr. Harrison, on behalf of the Elswick Ordnance Company, claiming that no such deduction ought to be made.

(signed) *James Fenton,*
Thos. E. Harrison.

(B.)

Sir, Leamington, 30 March 1863.

WE hereby undertake that the War Department shall be at liberty at any time within one month from this date to take such part of the stores now at Elswick Ordnance Works as they may decide to take at the prices agreed upon as their realizable value, by Messrs. Fenton and Harrison; and should the War Office, within one month, declare their wish to purchase any portion of the tools now at Elswick, that these shall be the subject of a future arrangement between the War Office and the Elswick Ordnance Company.

We are, &c.
The Elswick Ordnance Company,
per *G. W. Rendel.*

James Fenton, Esq.,
Allesley Villa, Leamington.

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— No. 6. —

MEMORANDUM of AGREEMENT made the 29th day of April 1863 between Her Majesty's Principal Secretary of State for the War Department of the one part, and *George Cruddas Richard Lambert* and *George Wightwick Rendel* (hereinafter styled "The Elswick Ordnance Company") of the other part.

WHEREAS by an indenture dated on or about the 16th day of January 1859 and made between Her Majesty's Principal Secretary of State for the War Department of the first part Sir William George Armstrong of Newcastle-upon-Tyne Knight of the second part and the said George Cruddas Richard Lambert and George Wightwick Rendel of the third part After reciting amongst other things that at the request of the said Principal Secretary and of the said Sir William George Armstrong and with a view and for the purpose of manufacturing ordnance fire-arms and other matters and things under and in pursuance of the inventions and patents assigned to the said Principal Secretary by the said Sir William George Armstrong the said George Cruddas Richard Lambert and George Wightwick Rendel had recently erected or were then erecting and might thereafter erect on land then or thereafter to be acquired and complete considerable works and machinery with all necessary plant and appurtenances at Elswick aforesaid at the estimated cost of fifty thousand pounds sterling which the said Principal Secretary did thereby assent and agree to And that the said Principal Secretary had with the consent of the said Sir William George Armstrong testified by his execution thereof offered to the said George Cruddas Richard Lambert and George Wightwick Rendel the contract for the manufacture at the said works under or in pursuance of the said inventions and patents of such guns as the Principal Secretary for the time being might from time to time require and the said George Cruddas Richard Lambert and George Wightwick Rendel had agreed to manufacture complete and deliver the said guns that might be so required subject to the terms and conditions thereinafter mentioned It was by the said indenture witnessed and the said Principal Secretary for himself and his successors did covenant with the said George Cruddas Richard Lambert and George Wightwick Rendel (*inter alia*) that if the said Principal Secretary for the time being should at any time thereafter countermand any order after the same should have been commenced and prosecuted or abstain from giving or cease to give orders to the said George Cruddas Richard Lambert and George Wightwick Rendel sufficient to keep the works erected and to be erected as aforesaid in full and adequate employment or if any act matter or thing should during the continuance of those presents be done or permitted omitted or suffered by or on the part of Her Majesty's Government or the said Principal Secretary for the time being by reason or means whereof the said works machinery and plant erected and to be erected as aforesaid or any part respectively should be rendered wholly or partially unproductive then and in either of such cases the said Principal Secretary for the time being would or should pay or cause to be paid unto the said George Cruddas Richard Lambert and George Wightwick Rendel a fair and equivalent compensation in money for loss sustained by reason of such notice of countermand or as the case might be for the expenditure already made or to be made in acquiring lands and hereditaments and in erecting the said works machinery and plant as aforesaid so far as the same works machinery and plant or any part thereof respectively should have become wholly or partially unproductive from the cause and in the manner aforesaid and so far as the expenditure on such works machinery and plant should have been from time to time sanctioned in writing by the said Principal Secretary for the time being the amount of such compensation to be settled and agreed upon by and between the said Principal Secretary and the said George Cruddas Richard Lambert and George Wightwick Rendel or failing and in default of such agreement then by two duly qualified valuers one to be named by the said Principal Secretary and the said George Cruddas Richard Lambert and George Wightwick Rendel or in case of difference between such valuers by an umpire to be appointed by the said valuers before they proceed to their valuation And whereas since the date of such last-mentioned indenture the said Principal Secretary sanctioned in writing an expenditure on such works machinery and plant amounting in the whole to the principal sum of 35,000 *l.* And whereas the said Elswick Ordnance Company gave notice to the said Principal Secretary that the said works machinery and plant had ceased to be adequately employed and that the same had become from that cause partially unproductive And whereas the said Principal Secretary in the month of January 1859 apprised the said Elswick Ordnance Company of his intention to terminate the said contract for the manufacture of ordnance fire-arms and other matters and things under the said inventions improvements and patents And whereas on the 27th day of February last the said Principal Secretary appointed James Fenton of Low Moor in the county of York civil engineer (since deceased) and the said Elswick Ordnance Company did appoint Thomas Elliot Harrison of 27 Great George-street Westminster civil engineer to settle and agree to the amount to be paid as a fair and equivalent compensation in money to the said George Cruddas Richard Lambert and George Wightwick Rendel under the terms of the said indenture or failing and in default of such agreement then to act as valuers and to nominate an umpire under the terms of the said indenture And whereas on the 30th day of March 1863 the said James Fenton and Thomas Elliot Harrison did sign the memorandum in writing hereunto annexed and marked A and the said George Wightwick Rendel on behalf of the Elswick Company did sign the memorandum addressed to the said James Fenton also hereunto annexed and marked B And whereas the said Principal Secretary has objected to the validity of the said memorandum marked A and refused to acknowledge the same as binding upon him And whereas with a view of terminating all differences arising upon the said memorandum the said parties hereto have agreed that the same memorandum marked A shall be hereby confirmed by the said Principal Secretary upon the terms and subject to the provisions following that is to say that the said Principal Secretary shall receive from the said Elswick Ordnance Company the plant and

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De Grey and Ripon.

Witness to the signing hereof by
Her Majesty's Principal Secretary of State

Cha. M. Clode
Solicitor to the War Department.

George Cruddas.
R. Lambert.
G. W. Rendel.

Witness to the signing hereof by
the within-named George Cruddas Richard Lambert and George Wightwick Rendel

Anderson Phalp
Elswick Engine Works
Newcastle-on-Tyne.

List of Machines in Nos. 1, 2, and 11 Shops.

Special Machines for Guns.

No of Machine.	Description of Machine.	Maker.	Date.	Invoice Price. £.	s.	d.	Value for a General Manufacture, or for Sale. £.	s.	d.	
	No. 1 Shop:									
1	Coil turning lathe	G. & B.	March 1859	285	–	–	–	–	–	These are convertible into three side lathes to turn 10 ft. long, by alterations and additions as follows:—New saddles and slide rests; new screws for whole length of bed and racks; one back head. Cost of conversion, say 120*l.* each, to produce three lathes, worth, say 250*l.* each. Credit Government for three heads, six saddles, and other work useless, 78*l.*
2	Ditto - ditto	,,	,, ,,	285	–	–	–	–	–	
3	Ditto - ditto	,,	May ,,	285	–	–	–	–	–	
4	Ditto - ditto	,,	,, ,,	285	–	–	390	–	–	
5	Ditto - ditto	,,	June ,,	291	–	–	78	–	–	
							468	–	–	
6	Ditto - ditto	,,	,, ,,	291	–	–	–	–	–	
9	Ditto - ditto	,,	July ,,	291	–	–	–	–	–	
10	Ditto - ditto	,,	,, ,,	291	–	–	153	–	–	Same machines as Nos. 1 to 6.
25	Coil boring machines	S. B. & T.	April ,,	300	–		60	–	–	Special {heads and beds convertible} say 1/5 per cwt.
26	Ditto - ditto	,,	,, ,,	300	–	–	60	–	–	
28	Double facing machine for coils	G. & B.	June ,,	450	–	–	40	–	–	Special. Not 11 tons 7 cwt., at 3*l.* 10*s.*
31	Quadruple coil boring machine	P. F. & Co.	,, ,,	550	–	–	—			
32	Ditto - ditto - ditto	,,	August ,,	550	–	–	—			
33	Ditto - ditto - ditto	,,	Sept. ,,	550	–	–	99	–	–	Entirely special. Weight about 33 tons.
104	Vertical boring machine	,,	Dec. 1859 Jan. 1860	321	5	–	70	–	–	Entirely special. Heads have hollow mandrils. Frames useless. Range only four feet. Weight about 14 tons.
104½	Ditto - ditto	,,	Dec. 1859 Jan. 1860	321	5	–				
126	Trunnion turning machine	S. B. & T.	Oct. 1859	327	–	–	45	–	–	Special. Two heads might be converted for lathes.
217	Quadruple boring machine	P. F. & Co.	Mar. 1860 1,159*l.* 10*s.*	308	–	–	100	–	–	Entirely special. Weight about 30 tons.
		S. B. & T.	Mar. 1860 35*l.*							
218	Ditto - ditto	,	April 1860 35*l.*	308	–	–				
		F. & Co.	July 1860 2*l.* 10*s.*							
219	Ditto - ditto	-	- - -	308	–	–				
220	Ditto - ditto	-	- - -	308	–	–				
			£.	7,205	10	–	1,095	–	–	

No. of Machine.	Description of Machine.	Maker.	Date.	Invoice Price. £. s. d.	Value for a General Manufacture, or for Sale. £. s. d.	
	No. 2 Shop:					
7	Rifling machine - - -	S. B. & T. -	April and May 1859.	234 9 2	100 – –	Entirely special. Weight about 23 tons. Beds worth, say, 30 *l.* each.
11	Ditto - - - -	„ -	April and May 1859.	234 10 –		
277	Ditto - - - -	„ -	Feb. - 1860	335 3 3		
273	Machine for screwing breech screws.	G. & B. -	May and June 1860.	349 10 –	- - -	Entirely special - - -
274	Machine for turning breech screws	S. B. and T. G. & B.	Jan. and May 1860.	297 – –	- - -	Special. Head convertible for 16″ lathe.
34	Machine for screwing breech screws.	G. & B. and F. & C.	July and Dec. 1859, and Jan. 1860.	207 5 –	- - -	Entirely special - - -
15	Machine for screwing breech ends	S. B. & T. and F. & Co.	June 1859, and Jan. 1860.	269 10 –	- - -	Entirely special - -
19	Ditto - - ditto - ditto -	S. B. & T. and F. & Co.	June 1859, and Jan. 1860.	269 10 –	155 – –	Entirely special - - -
81 to 84	4 boring machines in pit (south side) 390 *l.* each.	F. & Co. -	August 1859 to Jan. 1860	1,560 – –	140 – –	Not suitable for general work. Beds convertible for lathes. Say 30 *l.* each.
20	Chambering machine - -	S. B. & T. -	June - 1859	170 – –	25 – –	Special. Heads partly convertible for 18″ lathes.
91	Breech end boring machine -	„	Jan. - 1860	323 5 –	25 – –	Special.
	Chucks for Machines—*viz.*:					
	Vent pieces - - - -	„	Nov. 15, 1859	42 – –		
	Ditto - - - - -	„	„ 18, 1859	10 – –		
	Levers - - - - -	„	„ 15, 1859	30 10 –		
	Ditto - - - - -	„	Dec. 1, 1859 -	9 10 –	- - -	Special. Weight, say, four tons.
	Ditto - - - - -	„	Jan. 5, 1860 -	37 – –		
	Ditto - - - - -	„	„ 14, 1860	22 – –		
	Cap pins - - - -	„	„ 25, 1860	12 10 –		
	Vent pieces - - - -	„	Feb. 7, 1860 -	24 – –	12 – –	
			£.	4,437 12 5	457 – –	
	In Coiling Shop, No. 11:					
8	Tilt hammer - - - -	F. & Co. -	Dec. 1859 -	37 2 6	- - -	Special. For hammering copper facings.
D.B. 188	Coiling machine (in coiling shop) not erected.	W. G. A. & Co.	Aug. 1860 -	300 – –	45 – –	Entirely special. Weight, say, 15 tons.
D.B. 187	Coiling machine (in field) not erected, including mandrils.	W. G. A. & Co.	Aug. 1860 -	674 13 –		
			£.	1,011 15 6	45 – –	
			Total - £.	12,654 17 11	1,597 – –	Schedule referred to in Agreement between Secretary of State and Elswick Ordnance Company, dated 29th April 1863.

The Elswick Ordnance Company,
per *G. W. Rendel.*

— No. 7. —

The Elswick Ordnance Company and Her Majesty's Principal Secretary of State for the War Department.

Correspondence.

8, Great George-street, Westminster,
Sir, 18 April 1859.

It will be necessary to adopt immediate measures for procuring an adequate supply of shot, shell, and fuzes for the guns upon my principle, now in course of manufacture.

With this view I consider it will be necessary to have a foundry and turnery specially arranged for making them, and it will probably be deemed desirable as an eventual measure to have such an establishment attached to the rifle gun department at Woolwich, as well as to the ordnance factory at Elswick. At present, while the projectiles and fuzes are yet in a state of progress, it will be more convenient to have it at Elswick only, and the Ordnance Company there are willing to make the further outlay required for this purpose, and amounting to about 10,000 *l.*, upon the understanding that they shall receive the same guarantee in respect to that sum as they have already got in reference to an expected expenditure of 50,000 *l.* upon the gun works.

As it is really important that no time should be lost in commencing the arrangement for manu-

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facturing the projectiles, I beg leave to request your early attention to this subject.

I am, &c.
W. G. Armstrong.

The Secretary of State,
War Office.

War Office, Pall Mall, S. W.,
Sir, 20 April 1859.

I AM desired by Secretary Major General Peel to acknowledge the receipt of your letter of the 18th inst., stating that the Ordnance Company were willing to make a further outlay required for purposes mentioned in your letter, amounting probably to about 10,000*l.*, upon the understanding that they should receive the same guarantee in respect of that sum as they have already got in reference to an expected expenditure of 50,000*l.*, and to inform you in reply thereto that he is willing, and hereby agrees under the terms of the Indenture of the 16th January, to give them such guarantee, and he has given instructions to the solicitor of the department to make the necessary endorsement on the deed.

I have, &c.
B. Hawes.

Sir W. G. Armstrong, &c. &c.

8, Great George-street, Westminster,
Sir, 19 October 1859.

IT will now be necessary to determine whether the plant of the Elswick Ordnance Company is to be extended so as to render the existing premises of the Company available for the largest possible production they will admit of.

The guarantee already given to the Company now extends to an outlay of 60,000*l.*, and I consider that to give effect to the proposed extension a further capital of 25,000*l.* may be required, which would have to be added to the amount of the guarantee.

I beg therefore to be informed whether the Government be willing to extend the limit of the guarantee to 85,000*l.*

I have, &c.
W. G. Armstrong.

The Secretary of State,
War Office.

Elswick Ordnance Works,
Newcastle-upon-Tyne,
Sir, 26 September 1862.

WITH reference to the communication verbally made to us by the Director of Ordnance, to the effect that the Secretary of State was at present unable to give any orders for either guns or ammunition, we have the honour to request that this decision may be formally communicated to us in writing.

We request the favour of an immediate reply.

We have, &c.
The Elswick Ordnance Company,
Per *A. Noble.*

The Under Secretary of State,
War Office.

War Office,
Gentlemen, 2 October 1862.

I AM directed by Secretary Sir G. Lewis to acknowledge the receipt of your letter of the 26th ult., and in reply to inform you that he is unable at present to give your Company any further orders for either guns or ammunition.

I am, &c.
A. T. Tulloh,
Director of Ordnance.

The Elswick Ordnance Company.

Elswick Ordnance Works,
Newcastle-upon-Tyne,
Sir, 3 October 1862.

WE have the honour to acknowledge receipt of War Office letter of the 2d inst., 73/3/3294, informing us that no more orders for either guns or ammunition will be given to us at present.

The result of this decision will be that our works, which have for the whole of this financial year been very inadequately employed, will soon be closed in some departments entirely, and in all partially.

Under these circumstances we have no alternative but to give notice that we shall have to make a claim for compensation under the terms of our agreement with Her Majesty's Government.

I have, &c.
The Elswick Ordnance Company,
Per *G. W. Rendel.*

The Under Secretary of State,
War Office.

Elswick Ordnance Works,
Newcastle-upon-Tyne,
Sir, 21 November 1862.

AMONGST the continual applications we receive for the supply of guns, some are from merchants anxious to secure the production of Armstrong guns for their vessels trading in the eastern or other seas, in which they are liable to the attacks of pirates.

We request to know whether there would be any objection on the part of Her Majesty's Government to our entertaining these applications.

As we are now called upon to answer such an inquiry, we beg the favour of an immediate reply.

We have, &c.
The Elswick Ordnance Company,
Per *G. W. Rendel.*

The Under Secretary of State,
War Office.

War Office,
Sir, 24 Nov. 1862.

I AM directed by the Secretary of State for War to acknowledge the receipt of your letter of the 21st instant, and to acquaint you in reply that he is not prepared to give an immediate answer to your inquiry as to whether there would exist any objection on the part of Her Majesty's Government to your firm manufacturing Armstrong

strong guns for private individuals, but that the matter shall receive his consideration without unnecessary delay.

I am, &c.
A. T. Tulloh,
Director of Ordnance.

The Elswick Ordnance Company.

Elswick Ordnance Works,
Newcastle-upon-Tyne,
Sir, 25 November 1862.

We have the honour to acknowledge receipt of War Office letter of the 24th instant, 80/A/1524, informing us that the Secretary of State is not prepared to give an immediate answer to the inquiry made in our letter of the 21st instant, but that the matter will receive his consideration without unnecessary delay.

We beg to point out that the Secretary of State's letter amounts to a prohibition upon our proposal during the whole time that his decision is pending, and that the little prospect it affords us of an early decision, obliges us to reject, like all previous applications, the one to which we referred in our letter of the 21st instant.

At the same time we have the honour to observe that we should not have made the inquiry at all, were we not driven by the cessation of orders from the War Office to propose any reasonable expedient for preventing the entire suspension of our factory.

We have, &c.
The Elswick Ordnance Company,
Per *G. W. Rendel.*

The Under Secretary of State,
War Office.

War Office,
Gentlemen, 29 November 1862.

I am desired by Secretary Sir George Lewis to inform you that your letters of the 21st and 25th instant, together with your previous letter of the 3d ultimo, have been under his consideration.

With regard to your proposal that Sir George Lewis should sanction your manufacture of Armstrong guns for other purchasers than Her Majesty's Government, I am desired to observe that objections of considerable weight present themselves to that course.

The patent, as you are aware, was vested in the Secretary of State by Sir W. Armstrong, that the same "might be appropriated and employed exclusively for the public service," but unless Sir George Lewis is prepared to grant licenses to use the patent to other manufacturers, a course which, as at present advised, he is not prepared to adopt, his acceding to your request would be in effect an appropriation of the patent to the exclusive advantage of the Elswick Company.

With reference to the statements contained in your letter of the 3d ultimo, that "your works would soon be closed in some departments entirely, and in all partially," and that you have "no alternative but to give notice of your intention to make a claim for compensation under the terms of your agreement with Her Majesty's Government," Sir George Lewis directs me to remind you that such a claim can only arise on the termination of the contract, and also to inform you that he is prepared to enter forthwith into a negociation with your company for ascertaining the amount of compensation which would be due to the company under the contract in the event of its termination.

With this view, Sir George Lewis has given the necessary instructions to the solicitor to the department, who is authorised to confer with you on the claim which, under the contract of 16th January 1859, may be preferred on behalf of the Company.

I have, &c.
De Grey and Ripon.

Elswick Ordnance Works,
Newcastle-upon-Tyne,
Sir, 1 December 1862.

We have the honour to acknowledge receipt of War Office Letter of the 29th ultimo, and in reply to state that we shall immediately put ourselves in communication with the solicitor of the War Department.

I have, &c.
The Elswick Ordnance Company,
Per *G. W. Rendel.*

The Under Secretary of State,
War Office.

Elswick Ordnance Works,
Newcastle-on-Tyne,
Dear Sir, 16 December 1862.

1. With reference to the minute drawn up by you at our meeting last week, we find, after as careful an investigation as the time elapsed would allow of, that the figures are more correctly as follows:

2. Actual Expenditure at Elswick.

	£.
Land and buildings - - -	62,056
Machinery - - - - -	105,952
Total - - -	£. 168,008

3. Dividing the guaranteed expenditure in similar proportion between buildings and machinery, we have,—

	£.
Land and buildings - - -	31,395
Machinery - - - - -	53,605
Total Guarantee - - -	£. 85,000

4. The sum expended in land being comparatively small, we include it with the buildings as simplifying the statement.

5. The present value of the whole plant,* which has cost, as stated, 168,000 *l.*, is 137,108 *l.*, this sum being arrived at by deducting year by year 10 per cent. depreciation on the previous year's capital, and adding the current year's expenditure.

6. Now, although that portion of the whole plant which has been purchased under the guarantee must be taken to have depreciated in the same manner as the rest, yet it does not seem to us that such depreciation ought to go in reduction of the amount for which the Government are liable under the guarantee, but only in increase of the quantity of plant which they can claim to receive for that amount.

7. The

* *i.e.* land, buildings, and machinery.

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7. The sums charged for depreciation are devoted to additions, conversions, and substitutions of plant. Such additions are absolutely necessary to maintain the plant at its original value, or, which is the same thing, to keep up its power of production at the market price. If the expenditure under this head were to be discontinued, the power of producing at reasonable cost the article to be manufactured would rapidly be reduced. But it is an obvious necessity for us to maintain our power of production in the fullest efficiency, and therefore we have to lay out the depreciation sums in continual renewals.

8. Now, such being the case, under the assumption that the amount of the guarantee ought to be reduced by the sums charged for the depreciation, our position, after a very few years, would be this: that we should have a plant with no more than at the commencement of our agreement, yet the old and depreciated stock having been almost entirely replaced by the new, the plant would be no longer guaranteed; consequently we should be thrown back into the position from which the guarantee was expressly framed to shelter us, that is to say, having provided a special plant for a special manufacture, we should be liable to have it thrown useless on our hands by a discontinuance of the work for which alone it would be suitable.

9. We quite admit that the depreciation on plant having been taken into account by us as an item of cost of the articles produced, the present value of the plant must be taken to be its actual cost, less that depreciation.

10. As before stated, the whole expenditure on the factory has been 168,000 *l.*;* depreciation has reduced this sum to 137,000 *l.*, and if in the opinion of Government it affords a readier solution of the question for them to purchase the whole establishment, we are willing to make it over for that sum.

11. The cost of breaking up the plant and transferring portions to Woolwich, would be very large, and it may undoubtedly be applied with more advantage, as it now stands complete in itself. We have, however, no desire to press any particular view upon your notice, but are ready to endeavour, with your aid, to put any suggestion you may have to make into the most practicable shape.

We are, &c.
The Elswick Ordnance Company,
Per *G. W. Rendel.*

Sir, War Office, 20 January 1863.

I am directed by Sir G. Lewis to request you to lay before the Lords Commissioners of Her Majesty's Treasury the following statement connected with the Agreement with the Elswick Ordnance Company for the manufacture of Armstrong guns, a copy of which is enclosed.

This agreement was entered into on the 16th January 1859.

It is recited in this agreement that the Secretary of State for War had requested the Elswick Ordnance Company to erect works for the manufacture of guns, and had agreed to an expenditure on these works of 50,000 *l.*, a further expenditure of 35,000 *l.* in two sums of 10,000 *l.*, and 25,000 *l.* was subsequently, during the year 1859, authorised by the Secretary of State.

By the terms of the agreement it is provided that "if the Principal Secretary of State for the War Department for the time being shall at any time hereafter * * abstain from giving, or cease to give orders to the said George Cruddas, Richard Lambert, and George Wightwick Rendel, or the survivors or survivor of them, his executors or administrators, sufficient to keep the works erected, and to be erected as aforesaid in full and adequate employment * * by reason or means whereof the said works, machinery, and plant erected and to be erected as aforesaid, or any part thereof respectively, shall be rendered wholly or partially unproductive: * * then the Principal Secretary of State for the War Department for the time being will or shall pay, or cause to be paid unto the said George Cruddas, Richard Lambert, and George Wightwick Rendel, or the survivors or survivor of them, his executors or administrators, a fair and equivalent compensation in money for the loss sustained by reason of such notice of countermand, or, as the case may be, for the expenditure already made, or to be made, in acquiring lands and hereditaments, and in erecting the said works, machinery and plant as aforesaid, so far as the same works, machinery and plant, or any part thereof respectively, shall have become wholly or partially unproductive, from the cause, and in the manner aforesaid, and so far as the expenditure on such works, machinery and plant shall have been from time to time sanctioned in writing by the said Principal Secretary of State for the War Department for the time being * * the amount of compensation being fixed by arbitration."

The total amount of capital which the Elswick Ordnance Company have been authorised by the Secretary of State under his hand to expend, is 85,000 *l.*, but the Company state that they have actually expended a sum of 168,008 *l.*, as shown by the letter of the 16th ultimo. This letter was written to this department in consequence of a communication made to them through the solicitor, for the purpose of ascertaining the extent of their contingent demands.

Copies of the correspondence is herewith enclosed.

The amounts actually paid to the Company were, in 1860–61, 398,328 *l.*; in 1861–62, 397,785 *l.*; and in 1862–63 (to 10th January 1863), 81,000 *l.*

The orders which Sir G. Lewis has given the Elswick Ordnance Company during the present financial year, have not proved sufficient to keep their works fully employed, and from an early period of the financial year, they have addressed remonstrances to this office upon the subject, copies of which I have the honour to enclose.

Their Lordships will observe that in the letter of the 16th December before referred to, the Elswick Ordnance Company have made a distinct proposal that the Government should purchase their plant for 137,000 *l.*

The money actually paid to the Elswick Ordnance Company in 1860–61, and 1861–62, amounted to nearly 400,000 *l.* a year.

The total amount for guns and projectiles proposed to be provided in 1863–64, is 285,895 *l.*, which might be divided as follows, viz., for Elswick Ordnance Company, 144,600 *l.*; for Royal Gun Factories, 141,295 *l.*

If the whole of the money to be spent during the year were given to the Elswick Ordnance Company, the amount would fall short of that which they have been receiving when fully occupied

* *i.e.* on the premises tinted red on the plan supplied to you.

pied, and would barely satisfy the requirements of that firm under the agreement.

Such a course would, moreover, necessitate the closing, or the entire suspension of the Royal Gun Factories; measures which would be not only detrimental to the efficiency of the public service, but would be improvident and wasteful.

The utmost sum, therefore, which could be allotted to the Elswick Ordnance Company during the year 1863–64 is, 144,600 *l.*, which is little more than one-third of the amount which they have received when fully employed.

But although Sir George Lewis might insert in the Estimates for 1863–64, a sum of 144,600 *l.* as the proportion of guns and projectiles to be made during the year by the Elswick Ordnance Company, and a sum of 141,295 *l.* to be allotted to the Royal Gun Factory, he would be unable to give orders for the manufacture to anything like that extent, until the Special Committee now sitting upon the Armstrong and Whitworth guns, should have completed their labours, and made their report.

Indeed the only guns which could be ordered early in 1863–64, are as follows:—

7 40-pounder guns.
20 20-pounder guns.
47 9-pounder guns.

and their value, 8,980 *l.*, is a sum quite insufficient to enable the question of compensation to be avoided.

It would thus appear that the position at which matters have arrived, only leaves open to this department one of three courses, viz.:—

1. To order guns and projectiles with reference, not to the actual wants of the service, but to the amount which, under the agreement, would save the War Office liability to compensation.

2. To measure the orders by the real wants of the service, and to compensate the Company, during an indefinite period, for the losses which the want of orders might entail.

3. To terminate the agreement with the Elswick Ordnance Company by paying the sum ascertained to be due under its provisions.

Sir G. Lewis feels confident that, looking to the present position of the science of artillery, and to the obvious dictates of economy, in regulating the expenditure of this department, the Lords Commissioners will concur with him in thinking that the first course cannot be entertained.

The second course would afford an opening for claims, the extent of which it is impossible to foresee; and however large the payments might be, they would leave the Government in as disadvantageous a position as at first; so that if driven, ultimately, to terminate the agreement, the sum at which that termination must be purchased would not be diminished,

Consequently Sir G. Lewis would propose to adopt the third course, viz., to terminate at once the present agreement with the Elswick Ordnance Company, and to make the compensation necessary for this purpose. He therefore requests the consent of the Lords Commissioners of Her Majesty's Treasury to his entering into negotiation with the Company, for carrying this object into effect.

The total guaranteed capital is 85,000 *l.*, and that is, therefore, the limit of the amount which the War Office could be called upon to pay, even if the plant became their own.

But Sir G. Lewis has reason to hope that an arrangement could be come to, by which the Company would accept a less sum, retaining in their own hands the establishment and machinery.

Should Sir G. Lewis be able to arrange with the Company for a sum not exceeding 50,000 *l.*, he anticipates a saving on the vote for warlike stores for the present year, which would be sufficient to defray that sum. And if the amount to be paid exceeded that sum, the balance could be provided in the same vote for 1863–64.

This payment would leave a sufficient balance from savings to meet all excesses on the estimate, inasmuch as the money which would be required from Parliament for manufacturing guns and projectiles in the Royal Factories is considerably less than that which would be paid for similar guns and projectiles to the Elswick Ordnance Company. The proposed arrangement, by leaving Sir G. Lewis free to make all the guns and projectiles in the Royal Gun Factory, would enable him to diminish the Estimates for 1863–64, by 50,000 *l.* or 60,000 *l.*, and thus a margin would be allowed for any balance required for the Elswick Ordnance Company, to be paid in 1863–64.

Sir G. Lewis directs me in conclusion to observe that every day during which this question remains unsettled, the claim for compensation is liable to increase. He requests, therefore, that the Lords Commissioners of Her Majesty's Treasury will give their early attention to the subject, and he proposes that they should authorise him to make the best bargain he can with the Elswick Company, upon the principles which he has submitted to their Lordships, within the penal sum of 85,000 *l.*

Sir G. Lewis wishes it to be understood that in making this proposal he is not influenced by any dissatisfaction with the manner in which the Elswick Ordnance Company have fulfilled their contracts. This department has had every reason to approve of the zeal and energy with which its orders have been executed, and with the skill with which the work has been performed. The proposal which he finds himself compelled to make, has been suggested by a state of things which has arisen contrary to expectation, and which could not have been contemplated when the agreement was concluded.

(signed) *Douglas Galton.*

The Assistant Secretary, Treasury.

Treasury Chambers,
Sir, 26 January 1863.

With reference to your letter of the 20th instant, requesting authority to terminate the present agreement with the Elswick Ordnance Company for the manufacture of Armstrong guns, and to make the necessary compensation for this purpose, I am directed by the Lords Commissioners of Her Majesty's Treasury to acquaint you that under the circumstances represented, my Lords authorise the Secretary of State for War to make the best arrangement he can with the Elswick Ordnance Company, upon the principles which he has submitted to their Lordships, within the penal sum of 85,000 *l.*

My Lords do not find that the assent of this Board was obtained to the arrangement of 1859, with the Elswick Ordnance Company, an omission of which they think it right to take notice, with a

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view to the possible recurrence of any case hereafter involving analogous considerations.

I am, &c.
(signed) *F. Peel.*

Captain Galton,
&c. &c. &c.

War Office,
28 January 1863.

Gentlemen,

With reference to the recent correspondence which has taken place on the subject of your contract with this department for the supply of Armstrong guns, and particularly to your letter of the 16th December last, in which you offer to sell to the Government the whole of your establishment at Elswick for the sum of 137,000 *l.*, I am directed by Sir G. Lewis to inform you that in preparing the Estimates for the year 1863–64, he has attempted to calculate the probable amount of orders which he would be able to give to your Company during the next financial year.

From the best calculation he can frame, Sir G. Lewis is led to anticipate that those orders will fall short of the amount sufficient to afford a profitable return to the Company.

Under these circumstances, it has become necessary for him to choose between the three following courses:—

1. To order guns and projectiles with reference not to the actual wants of the service, but to the amount which under the agreement with your Company would save the War Office from liability to compensation.

2. To measure the orders by the real wants of the service, and to compensate your Company during an indefinite period, for the losses which the want of orders might entail.

3. To terminate the agreement with your Company, by paying the sum ascertained to be due under its provisions.

For reasons which he has communicated to the Lords Commissioners of Her Majesty's Treasury, but which it is unnecessary here to repeat, Sir G. Lewis, with the consent of their Lordships, has determined to adopt the third course.

He therefore desires me to announce to you his intention to terminate the contract under the prescribed stipulations.

The result of this measure will be that the War Department will be called upon to compensate your Company for the loss which they will sustain by reason of the Secretary of State ceasing to give orders; the amount of such compensation to be founded upon the expenditure incurred by the Company in acquiring lands and buildings, and erecting machinery for the purposes of the agreement, so far as the expenditure on land, buildings, plant, and machinery shall have been from time to time sanctioned by the Secretary of State.

I am to request, therefore, that as a preliminary measure, you will furnish Sir G. Lewis with your estimate of the compensation to which, in consequence of this step, you consider your Company to be entitled under the agreement.

I have, &c.
(signed) *C. M. Clode.*

The Elswick Ordnance Company.

Elswick Ordnance Works,
Newcastle upon Tyne,
29 Jan. 1863.

Sir,

We have the honour to acknowledge receipt of your letter of the 28th instant, announcing to us the intention of the Secretary of State to terminate the agreement of the 16th January 1859, between Her Majesty's Government and ourselves, under the prescribed stipulations, and requesting us to furnish as a preliminary measure an estimate of the compensation to which, in consequence of this step, we consider ourselves entitled under the agreement.

In compliance with your request, we now beg to state that we consider ourselves entitled to claim reimbursement of the whole amount guaranteed viz., 85,000 *l.*, the Government entering into possession of the property in land, buildings, and machinery acquired under that expenditure for the purposes of the agreement.

We further consider that we have a claim for compensation for loss sustained as follows:—

1. By reason of want of employment in some branches of our manufactory during the past year, whereby a large amount of capital, fixed and floating, was rendered unproductive, the general charges of the establishment having to be paid notwithstanding. The loss from this cause we estimate at about 5,000 *l.*

2. By reason of the abrupt termination of the agreement, whereby we are left without any trade to defray the expense of salaries, rates, taxes, interest of capital and other charges, which cannot be put an end to all at once.

By the same cause we are left burdened with a large amount of stores, which under a running contract, must be kept on stock to meet demands.

The loss under this head we consider will not fall short of 5,000 *l.*

We have, as you are aware, expended on plant nearly double the amount of our guarantee. This expenditure has partly been incurred to enable us to meet pressing demands for guns and projectiles, their variety of pattern and continually increasing size.

But it has also in a great measure been incurred in the substitution of machinery for hand labour, whereby greater economy of manufacture has resulted, of which economy Government has had the benefit.

We have been led into a more extended use of machinery than was perhaps prudent under the circumstances, by the fact of our prices having been always considered with reference to the cost of production at Woolwich, where there has never been any hesitation in incurring expenditure on machinery to effect annual saving of wages.

On our side we have always acted upon equitable principles in our dealings with the Government, and we have on several occasions voluntarily reduced prices already agreed upon, when we have succeeded beyond our expectations in reducing the cost of manufacture.

We may refer you to the following cases:

1. On our first contracts for 40-pounder rifled guns, after 164 guns had been paid for at the rate of 350 *l.* per gun, and 56 guns remained chargeable at the same rate, we proposed in our letter of 2d February 1861 a reduction to 310 *l.*, and made a rebate on previous payments of 40 *l.* per gun, thereby voluntarily resigning a sum of 8,800 *l.*

2. In the same manner, in 1861, having contracts to supply 110-pounder rifled segment shells at

at a fixed price, we proposed in a letter to the War Office, dated 23d September 1861, to reduce the rate on the uncompleted portion of the contracts by 2 *s.* 10 *d.* per shell, thereby resigning a profit of 5,550 *l.*

3. By our letter of the 8th February 1861, we made a reduction in the prices of all projectiles and fuzes then under contract, which might remain undelivered at the end of the then current financial year, effecting a saving to Government of 1,771 *l.*

4. When the first 12-pounder rifled guns were ordered in 1859, the Government desired to fix the price by contract at 250 *l.* each, a cost arrived at from the experience we had had in making the experimental guns; but at our own instigation, and in the expectation that the special machinery we were then introducing might enable us to reduce the cost considerably, the price was left open, and the guns were actually charged at 170 *l.*, whereby a saving to the Government of about 7,000 *l.* was effected.

Thus we have in the four cases cited voluntarily resigned sums amounting in all to 23,000 *l.*

Besides this, we have never failed in cases where contract prices have been fixed provisionally, "subject to such reduction as the progress of the manufacture may show to be practicable," to make the fullest reduction due under such a stipulation. We may instance the case of late contracts for 50 40-pounder rifled guns and 100 70-pounder rifled guns, by which the prices were fixed provisionally at 285 *l.* and 510 *l.*, which prices in our letter to the War Office of the 12th February 1862, we undertook to reduce to 249 *l.* and 460 *l.* respectively.

We cite all these cases merely to show that we have always acted in an equitable spirit, and we submit that in accepting the benefit of these acts, the Government has in a measure pledged itself to act towards us in a similar spirit.

If it be held that no claim can be allowed for loss arising out of our unguaranteed expenditure, then we think that those sums which we have voluntarily resigned, and which may be said to have been saved in great measure by that very expenditure, ought in fairness to be placed to our credit as part compensation for our unrecognised loss.

The total amount of our claim would then stand as follows:—

	£.
Reimbursement of guaranteed expenditure - - - -	85,000
Loss sustained by inadequate employment - - - -	5,000
Loss by abrupt termination of the agreement - - - -	5,000
Sums resigned at various times on contracts - - - -	23,000
Total	£.118,000

The property acquired under the guarantee is necessarily mixed up with that acquired by unguaranteed expenditure; consequently it will be difficult to effect any arrangement by which Government may enter into possession of the former separately, with a view of turning it to account in sites for the manufacture of guns, projectiles, and fuzes.

It is impossible to move the buildings, and the cost of taking down the machinery and re-erecting it elsewhere, will probably be found to make that mode of dealing with it inexpedient.

To us the plant has little value, from the moment it ceases to be employed in the manufacture for which it was specially designed, and it is a matter of much speculation to what extent and at what cost it could be made available for any new purpose.

After the best consideration that the time has enabled us to give the question, we are of opinion that its value for our own use, or for sale, is not more than 20,000 *l.*

But with a view of obtaining a speedy settlement, we are willing to take this property in discharge of the additional claims which we have specified above, and which we have shown to amount approximately to 33,000 *l.*

We should wish it to be understood that we make this proposition without prejudice to any claim which we may have to advance, in the event of a settlement being delayed by a reference to arbitration.

We have, &c.
The Elswick Ordnance Company,
per *G. W. Rendel.*

C. M. Clode, Esq., &c. &c.
War Office.

War Office,
Gentlemen, 2 February 1863.

I am desired by Secretary Sir George Lewis to acknowledge the receipt of your letter of the 29th ultimo (but which reached me only yesterday), and to apprise you that before Sir George Lewis can enter into any arrangement based upon the statements contained therein, it appears to me essential that he should be furnished with a correct estimate of the present actual value of the land, works, and buildings at Elswick, and therefore he proposes to appoint some gentleman competent to furnish him with this information, who will visit Elswick, and (with your permission) enter upon an examination and valuation of the property.

I have, &c.
(signed) *C. M. Clode.*

The Elswick Ordnance
Company.

Elswick Ordnance Works,
Newcastle-on-Tyne,
Sir, 5 February 1863.

We have the honour to acknowledge the receipt of your letter of the 3d instant.

We shall be happy to see the gentleman whom the War Department may appoint to value the guaranteed property here, and will give him every assistance and information he may require.

We are, &c.
The Elswick Ordnance Company,
per *G. W. Rendel.*

C. M. Clode, Esq.,
&c. &c. &c.
War Office.

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War Office,
Gentlemen, 5 February 1863.

I AM desired by Secretary Sir George Lewis to inform you that he has appointed Mr. J. Fenton, of Low Moor, to make a valuation, and act as valuer on his behalf, under the provisions of the deed of June 1859.

To enable Mr. Fenton to discharge this duty, it appears to him essential that he should be furnished with a detailed list of the machinery and buildings erected under the several guarantees, viz., for 50,000*l.* covered by the deed of January 1859; for 10,000*l.* covered by Mr. W. Armstrong's letter of the 18th April 1859, and for 25,000*l.* covered by his letter of the 19th day of February 1859, and of the cost of each building and machine, together with the date of the erection or acquisition, and of its first commencement to work.

Before Mr. Fenton makes any report to the Secretary of State, he desires to be placed in communication with the valuer acting on behalf of the Company, as he assures the Department that a material saving of time and expense would be effected if your appointment of a valuer was made at once, or you declared your intention of leaving the matter wholly to the decision of Mr. Fenton, if the Secretary of State should (if so advised) take the same course.

I have, &c.
(signed) *C. M. Clode.*

The Elswick Ordnance Company.

Elswick Ordnance Works,
Newcastle-upon-Tyne,
Sir, 6 February 1863.

WE have the honour to acknowledge the receipt of your letter of the 5th instant, informing us that Sir George Lewis has appointed Mr. Fenton, of Low Moor, to make a valuation of our guaranteed property.

We presume that the object of the proposed valuation is simply to test the fairness of the value put upon the guaranteed plant in our letter of the 29th January, and that we are not called upon to nominate on our behalf a gentleman to arbitrate on the whole question.

It will be necessary that we should be informed on this point before we can name a gentleman to meet Mr. Fenton.

We are, &c.
The Elswick Ordnance Company,
per *G. W. Rendel.*

C. M. Clode, Esq., &c.
War Office.

War Office,
Gentlemen, 7 February 1863.

I AM desired by Secretary Sir George Lewis to acknowledge the receipt of your letter of 6th instant, and to observe that the deed (the terms of which Sir George Lewis feels himself bound to adhere to) provides that an account of all monies expended under the guarantees, shall be furnished to the Secretary of State, and that in the event of no adequate employment being given for that expenditure, compensation (to be agreed and settled by valuers) shall be paid to the Company.

In the absence of definite information, 1st, as to the original expenditure under the guarantees; and, 2dly, as to the loss likely to accrue from it, it is impossible for Sir George Lewis to come to any agreement, and, therefore, information from you on the first point, and from Mr. Fenton on the second point, are matters necessary preliminary to either an agreement or an arbitration.

It would, however, as Sir George Lewis is advised, greatly facilitate the settlement of your claim if some gentleman was appointed to act with Mr. Fenton, and agree on your behalf (if it be possible) as to the present actual value of the property acquired under the guarantees.

If it should so happen that no agreement can be come to between yourselves and the Department, then Mr. Fenton, on behalf of the Secretary of State, and the gentleman appointed on your behalf, would act as valuers and select an umpire, as provided for by the deed.

I have, &c.
(signed) *C. M. Clode.*

The Elswick Ordnance Company.

Elswick Ordnance Works,
Newcastle-upon-Tyne,
Sir, 8 February 1863.

WE have the honour to acknowledge receipt of your letter of the 7th instant, and to inform you that Mr. Thomas E. Harrison, civil engineer, has consented to act on our behalf as valuer with Mr. Fenton.

We are proceeding with the schedule you require, and will inform you as soon as it is completed.

We are, &c.
The Elswick Ordnance Company,
per *G. W. Rendel.*

C. M. Clode, Esq., &c.
War Office.

Elswick Ordnance Works,
Newcastle-upon-Tyne,
Sir, 16 February 1863.

WE have the honour to inform you that a schedule of our guaranteed plant will be ready for examination on Saturday next; and we request that an appointment may be made for Mr. Fenton to meet Mr. Harrison here on that day.

It is, of course, of the utmost importance to us that a settlement should be made as early as possible, and a meeting of the valuers here would greatly accelerate the proceedings.

We have, &c.
The Elswick Ordnance Company,
per *G. W. Rendel.*

C. M. Clode, Esq., &c.
War Office.

War Office,
Gentlemen, 17 February 1863.

I AM desired by Secretary Sir George Lewis to acknowledge the receipt of your letter of the 16th instant, and to apprise you that he has sent a copy thereof to Mr. Fenton to his present address, Allesley Villa, Leamington, with a request that he will (if he can conveniently do so) attend the appointment you have suggested, and facilitate by any other means in his power the early settlement of your claim.

Mr. Fenton will, no doubt, desire to go carefully over the schedules, as well as over the plant to which you refer; and, therefore, if you could send to him direct to Leamington any part thereof that may be now ready the end you have in view would, no doubt, be very considerably advanced.

I have, &c.
(signed) *C. M. Clode.*

To the Elswick Ordnance
Company,
Newcastle-on-Tyne.

War Office,
Gentlemen, 19 February 1863.

I AM desired by Sir George Lewis to send you a copy letter, received from Mr. Fenton, of the 18th instant, and a copy of his appointment, which Sir George Lewis will sign in the course of the day.

It will be expedient that you should give a formal appointment to Mr. Harrison, and that such appointment should (if you see no objection) be in a similar form to that held by Mr. Fenton, and that both appointments should be produced for authentication at Elswick on Saturday, before these gentlemen enter upon the duties to which they have been severally appointed.

I have, &c.
(signed) *C. M. Clode.*

To the Elswick Ordnance
Company.

Elswick Ordnance Works,
Newcastle-on-Tyne,
Sir, 21 February 1863.

MR. FENTON and Mr. Harrison met here this day; but as we found ourselves unable to sign, in the form you propose, an authority to Mr. Harrison to act on our behalf, no progress could be made in the business.

By your recent correspondence with us we were led to suppose that the object of the present proceeding was to endeavour to effect an arrangement of our claims through the intervention of an assessor nominated on each side, and with the ultimate intention of referring, if necessary, all questions in difference to an arbitration in which these two assessors would act as referees and appoint an umpire.

But to effect an agreement upon equitable terms, it seems necessary that the assessors should be authorised to take into consideration all the circumstances of the case.

This they would not be able to do under the terms of Mr. Fenton's appointment, and we do not see how we can furnish Mr. Harrison with a similar appointment without abandoning claims which we confidently put forward as most reasonable and just.

We, therefore, request that you will reconsider the wording of this document, with a view of giving more latitude to the referees, and we return it to you in a slightly modified form, which, we think, would answer the purpose.

Mr. Fenton and Mr. Harrison have arranged to meet here again on Friday next, and, in order to prevent unnecessary delay in settling the terms of the reference, Mr. Rendel will proceed to London, and will be glad, if convenient, to see you upon the subject on Tuesday morning.

We are, &c.
The Elswick Ordnance Company,
per *G. W. Rendel.*

C. M. Clode, Esq.,
&c. &c. &c.
War Office.

War Office,
Gentlemen, 25 February 1863.

I AM desired by Secretary Sir George Lewis to acknowledge the receipt of your letter of the 21st instant, stating your objection to give an authority to Mr. Harrison similar to that held by Mr. Fenton, to settle and agree to the fair and equivalent compensation in money to be paid to you under the deed of January 1859.

Sir George Lewis observes that you propose to alter the terms of this appointment by adding a clause authorising Mr. Fenton "to take into consideration all claims which may be advanced by you as affecting the amount which ought to be paid to you under all the circumstances of the case;" and that in your letter you urge the necessity for this clause to enable the valuers to effect an agreement upon equitable terms.

Sir George Lewis is not prepared to assent to your proposal, which practically appears to amount to this: that the valuers, instead of adhering to the terms of the existing agreement, shall have power to make another agreement based upon such claims (at present undefined) as may be advanced by you under all the circumstances of the case.

I have, &c.
(signed) *C. M. Clode.*

War Office,
Sir, 31 March 1863.

ADVERTING to previous correspondence respecting the terminating of the contract held by the Elswick Ordnance Company for the manufacture of ordnance, &c., I am directed by Secretary Sir G. C. Lewis to forward you, for the information of the Lords Commissioners of Her Majesty's Treasury, a copy of the award, dated 30th instant, made by the arbitrators to whom the matter was referred, and to state that, in accordance with such award, Sir G. C. Lewis has authorised the payment to the firm named, out of the Votes for 1862-63, of the sum of 65,535 *l.* 4 *s.*

I am, &c.
(signed) *Douglas Galton.*

The Under Secretary
to the Treasury.

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Elswick Ordnance Works,
Newcastle-upon-Tyne,
Sir, 6 April 1863.

We shall feel obliged if you will inform us when we may expect payment to be made to us upon the award of Messrs. Fenton and Harrison, dated 30th ultimo.

It is a matter of great importance to us that we should receive the money without delay, which must be our excuse for making this application.

We beg the favour of a reply by return,

And have, &c.
The Elswick Ordnance Company,
per *G. W. Rendel.*

The Under Secretary of State,
War Office.

War Office,
Gentlemen, 7 April 1863.

I am desired by Secretary Sir George Lewis to acknowledge the receipt of your letter of the 6th instant, requesting to be informed when you may expect payment to be made to you upon the award of Messrs. Fenton and Harrison, dated the 30th ultimo, and to reply thereto, that as Sir George Lewis is advised that this document is bad both in form and substance, he is not prepared to make any issue of public money upon the authority thereof.

I have, &c.
(signed) *C. M. Clode.*

The Elswick Ordnance
Company,
Newcastle-upon-Tyne.

Elswick Ordnance Works,
Newcastle-upon-Tyne,
Sir, 8 April 1863.

We have the honour to acknowledge receipt of your letter of the 7th instant, informing us that the Secretary of State is advised that the award of Messrs. Fenton and Harrison is "bad both in substance and form," and that he can make no payment to us upon its authority.

We beg to be informed in what particulars this award is considered to be defective.

We also beg to be furnished with a copy of Mr. Wickins' opinion on the papers submitted to him, bearing on the depreciation question, and we think ourselves justified in applying for this, having already furnished your referee with a copy of Mr. Bullar's opinion on the same question.

We have, &c.
The Elswick Ordnance Company,
per *G. W. Rendel.*

C. M. Clode, Esq.,
War Office.

Treasury Chambers,
Sir, 13 April 1863.

With reference to your letter of the 31st ultimo, enclosing copy of the award made by the arbitrators to whom the question of the termination of the contract held by the Elswick Ordnance Company for the manufacture of ordnance, &c., was referred, I am directed by the Lords Commissioners of Her Majesty's Treasury to acquaint you, for the information of Secretary Sir G. Lewis, that my Lords approve of the payment of 65,535*l.* 4*s.*, which has been made to the firm, in accordance with such award.

I am, &c.
(signed) *F. Peel.*

Captain Galton.

The Electric and International Telegraph Company, incorporated 1846.

Solicitor, War Department, to Elswick Ordnance Company.

Will Mr. Rendel and Mr. Lambert come to London and confer?

From Elswick Ordnance Company, to Solicitor to War Office, D. Q.

Mr. Rendel and Mr. Lambert are absent to-day; they will proceed to London to-morrow—be at War Office on Thursday.

Newcastle-upon-Tyne,
Sir, 21 April 1863.

We are in receipt of your telegram, requesting Mr. Rendel and Mr. Lambert to come to London and confer. Mr. Rendel is from home to-day, but is expected back this evening. He will proceed to London to-morrow, and call upon you on Thursday morning at 12 o'clock. Mr. Lambert is already in the neighbourhood of London, and has been written to, requesting his attendance at the same time.

I have, &c.
The Elswick Ordnance Company,
per *Wm. D. Cruddas.*

C. M. Clode, Esq.,
War Office.

8, Great George-street,
Westminster, S. W.,
Sir, 29 April 1863.

We beg respectfully to urge our claim for an immediate payment of the sum now settled to be due to us by the memorandum of agreement, completed and signed by us yesterday.

In assessing the amount of compensation due, it has been always assumed that payment would have been made, at latest, by the 31st March, *i. e.*, a month ago.

The magnitude of the amount involved, and the importance to us of having our claims finally settled will, we trust, be a sufficient excuse for our pressing for payment, now that the amount is agreed upon.

Mr.

Mr. Rendel remains in town entirely with reference to this business, and will attend at the War Office at any time named to receive payment.

We are, &c.
The Elswick Ordnance Company,
per *G. W. Rendel.*

C. M. Clode, Esq.,
&c. &c. &c.
War Office.

War Office,
Gentlemen, 1 May 1863.

I am desired by Lord De Grey and Ripon, to forward for your signature, in duplicate, the agreement come to on the 29th ultimo, for the settlement of all demands arising for compensation under the terms of the Indenture of January 1859; and to request the return of the agreement, having annexed thereto the original memorandum of Messrs. Harrison and Fenton, dated the 30th March last.

I have also to enclose an order for 4,760*l.* 4*s.* in favour of George Cruddas, &c., the receipt of which you will be pleased to acknowledge to me.

I have, &c.
C. M. Clode.

The Elswick Ordnance Company,
Newcastle-upon-Tyne.

Newcastle-upon-Tyne,
Sir, 2 May 1863.

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We have the honour to acknowledge receipt of your letter, of yesterday's date, enclosing order on the Paymaster General for 4,760*l.* 4*s.*, which we have passed through the Bank of England in the usual manner.

The agreement in duplicate, which accompanies your letter, shall be completed and forwarded to you on the return of Mr. Rendel, who is absent from the works for a day or two.

We have, &c.
The Elswick Ordnance Company,
per *D. Cruddas.*

C. M. Clode, Esq.,
War Office.

Newcastle-upon-Tyne,
Sir, 5 May 1863.

We have the honour to return you the agreement, with the original memorandum of Messrs. Fenton and Harrison attached, duly executed.

We are, &c.
For the Elswick Ordnance Company,
Wm. D. Cruddas.

C. M. Clode, Esq.

Appendix, No. 49.

App. No. 49.

PAPER furnished by Sir *W. G. Armstrong*, and referred to in his Evidence of 18 May 1863.

VENT PIECES.

HISTORY of the changes in pattern and material of the vent-piece for the different natures of Armstrong guns, with the dates of the authorities for these changes.

	6-POUNDERS.
20 September 1861 (73—3—2262).	Material changed from steel to wrought-iron.
11 January 1862 (73—3—2603).	Strengthened vent-piece having projection on back and with crosshead sanctioned.
1 April 1862 (73—3—2830).	Vent-piece assimilated to the 12 and 9-pounders. To have projecting back and projecting copper facing.
25 Jan. 1862 (73—23—3113).	Material changed from common wrought-iron to Swedish C ⟨ iron.
	9-POUNDER.
25 June 1862 (73—3—3113).	Material changed from common wrought-iron to Swedish wrought C ⟨ iron.
	12-POUNDER.
15 December 1860 (80—A—910).	New form of vent-piece to be made having projecting back, crosshead, and flush copper.
20 September 1861 (73—3—2262).	Material changed from steel to wrought-iron.
16 January 1862 (73—3—2603).	Wrought-iron vent-piece strengthened, and with the projection on back, approved.
25 June 1862 (73—3—3113).	Material changed from common wrought-iron to Swedish wrought-iron.
	20-POUNDER.
20 September 1861 (73—3—2262).	Nature of material changed from steel to wrought-iron.
11 January 1862 (73—3—2603).	Wrought-iron strengthened vent-piece with projecting back approved.
25 January 1862 (73—3—3111).	Nature of material changed from common wrought-iron to common Swedish wrought C ⟨ iron.
	40-POUNDER.
26 February 1861 (57—2—4508).	Improved vent copper-ring and bouches.
20 September 1861 (73—3—2262).	Nature of material changed from steel to wrought-iron.
4 April 1862 (73—3—2915).	Strengthened vent-pieces with projecting back and new pattern copper approved provisionally.
2 May 1862 (73—3—2935).	
25 January 1862 (73—3—3113.)	Materially changed from common wrought-iron to Swedish wrought C ⟨ iron.
	110-POUNDER.
20 September 1861 (73—3—2262).	Nature of material changed from steel to wrought-iron.
17 March 1862 (73—3—2805).	Alteration in form of shackle, and of joint attached to cross head projection on back added.
25 June 1862 (73—3—3113).	Material changed from wrought-iron to Swedish C ⟨ iron.

RECORD of all TRIALS at *Shoeburyness* of ARMSTRONG RIFLED 300-POUNDER GUNS against IRON PLATES.

Shoeburyness, 3 March 1863.

Number of Round.	Nature of Ordnance.	Projectile.					Charge in Lbs.	Length of Charge in Inches.	Elevation.	Range in Yards.	Deflection.	Effects.		Remaining Velocity at 563 feet.	REMARKS.
		Nature.	Weight in Lbs.	Form.	Length in Inches.	Diameter.						Depth of Indent in Inches.	Diameter of Indent in Inches.		
3	300-Pr. Armstrong rifled shunt gun.	Cast Iron Solid Shot, hollow-headed.	230	Cylindrical *F. E., with hollow hemispherical head.	19·	–	45	18·5	20′	200	2′R.	1·45	10·0 × 9·5	1400·6	* 3. Struck No. 3 plank 1′ 9″ from the bottom; the plank was cracked across its width through the indent; the crack made by round No. 1 extended to a bolt hole, and the plank was cracked completely through its width and thickness at 1′ 5·5″ from the top, the crack being 0·4″ wide on the front, and having extended from an old crack, 4″ long made by the previous day's firing; the plank was driven in 1·8″ for 3′ 6″ from the bottom; the bottom bolt of the plank started 0·2″, and the two bolts next above were driven in 0·2″ and 0·4″. At the back, a through bolt, just below embrasure, broken off; vertical frame piece, or "upright of frame," bent considerably at seat of blow; gaping of horizontal planks from front planks, at left side of embrasure, increased now to an inch; horizontal frame piece, or cross stay, at bottom curved back considerably; a through bolt (masked by the above frame piece) broken, and its head brought up pressing against the frame piece; washers of No. 2 through bolt from the top of right row, squeezed up; bottom through bolt, right side, loose, being broken in front; vertical frame piece, right of all, slightly curved; and a partial crack (former day's practice) now continued through the thickness of iron.
6	300-Pr.	Solid Cast Iron Shot.	307	Cylindrical † R. E.	18·5	–	45	18·5	25′	200	4′R.	2· on Plank 3, and 1·3 on Plank 4.	12·5 × 12	1228·4	† 6. Struck at the junction of planks 3 and 4, 3′ 2″ from the top of the target; a portion of the shot remained in plank 3; the cracks at the top and bottom of this plank made by round No. 3 much enlarged, and now measure 0·6″ and 0·9″ in width. At the back, a through bolt (the second from the top of the third row from left) broken; through bolt, top of second row from left, much squeezed up; vertical frame piece considerably bulged (now 1·2″); horizontal planks 2, 3, and 4 from top also bulged; 3 and 4 horizontal planks opening out from front planks 1″ at left side of embrasure.

* Flat ended. † Round ended.

* The thickness of the Target at Plank 3 was 17″. † The thickness at Plank 4 was 12″.

These rounds were fired at Captain Inglis's shield, which was of the following construction:—The shield measured 11′ in length by 8′ 2″ in height, and contained an embrasure 3′ 6″ high × 2′ 4″ wide. It was composed of vertical planks of hammered iron of various dimensions, namely, 1′ 11″ × 8″, 1′ 11″ × 7″, 1′ 7¼″ × 8″, 1′ 7¼″ × 7″, and 1′ 7¼″ × 6″, backed by horizontal planks of rolled iron, 14″ wide by 5″ thick, and secured by 3′′ screw bolts.

The planks were numbered 1 to 5, commencing on the left.

EXTRACTS from the Report of the Committee on the Trial of Captain Inglis's Shield.

No. 3 round was from the Armstrong 300-pounder muzzle-loading shunt gun; the shot, which was of cast iron, was hollow-headed, and weighed 230 lbs.; charge 45 lbs.; it struck 1′ 9″ from the bottom, made only a small indent, but cracked the plank struck, across in two places, broke one bolt with lead washers at the screw, made a considerable bulge on the back of the shield, started two bolts slightly, and had considerable effect on the shield. The velocity was 1,400 feet.

No. 6 round was from the Armstrong 300-pounder; it struck at the junction of two planks, made indents in one of 2″, in the other 1″·3, and a portion of the shot remained in the hole; broke a bolt with india-rubber washer, and cracked the plank in two places. If the shield was exposed to continued firing from such a gun, it must soon be destroyed.

(True extract)
A. Harrison, Captain Royal Artillery,
Secretary.

RECORD of all Trials at *Shoeburyness* of Armstrong Rifled 300-pounder Guns against Iron Plates—*continued.*

Shoeburyness, 17 March 1863.

Number of Round.	Nature of Ordnance.	Projectile.				Bursting charge of Shells.	Charge in Lbs.	Elevation.	Range in Yards.	Deflection.	Effects.		Velocity at 508 feet.
		Nature.	Weight.	Form.	Length.						Depth of Indent in Inches.	Diameter of Indent in Inches.	
			Lbs. oz.		″	*Lbs. oz.*		′		′			
7	300-Pounder Armstrong Rifled Shunt Gun.	Steel solid Shot.	301 0	Cylindrical. R.E.	14·05	–	45	27	200	4 R.	6·2	12·9	1293·1
8	Ditto -	Steel shell	288 0	Cylindrical, with Cast-iron head.	20·0	11 0	,,	25	,,	,,	–	–	1318·4
13	Ditto -	Wrought Iron solid Shot.	163 0	Spherical, 10·337 in. diameter.	–	–	45	20	,,	nil	3·7	13·	1627·0

The target fired at on the 17th March 1863, was composed of three plates of the following dimensions and weights:—

No.						*Cwts. qrs. lbs.*		
1.—13′ 4″	× 3′	6·75″	× 5·5″	-	-	-	93	1 6
2.—12′ 2·75″	× 3′	7·75″	× 6·5″	-	-	-	103	2 0
3.—11′ 9·25″	× 3′	8·375″	× 7·5″	-	-	-	116	2 10

They were secured by 2 ½″ conical-headed bolts, with double nuts, to the frame of Mr. Samuda's target (2 ½″ thick), and were backed by timber for one-half their length; the 5 ½″ plate by 9″ the 6 ½″ plate by 8″, and the 7 ½″ plate by 7″, so that the front of the target presented a plane surface; india-rubber washers were placed under the bolt heads.

The plates were divided into compartments by seven vertical lines, numbered from 1 to 7, and by three horizontal lines; the backed portion of the plates extended from 1 to 4, and the unbacked portion from 4 to 7.

REMARKS.

7. Struck the 7½″ plate 8″ to the left of 4 vertical and 7·5″ above 2 horizontal, on a rib; the top of the plate was driven in 1·3″ in a length of 7′; bolt above the hole made by this shot started 0·9″; a narrow crack, 4″ long, from the top of the plate; the right side of the plate started out from the backing 0 7″ at top and 0·8″ at bottom, the left side started out 0·5″ at top and 0·7″ at bottom; the shot set up 2·25″ and was cracked at the side through the "aillette" holes and also across the rear. At the back, twenty rivets broken; no nuts off the through-bolts, but many washers much compressed and altered in form; two iron hoops, for resisting the spread of the washers, driven off, and one broken; angle iron on vertical rib cracked through and bent out; horizontal angle iron cracked and started considerably; fastenings of heavy iron shelf-piece broken, and shelf-piece ready to give way. This plate exhibited a considerable amount of fibre, in the hole made by the shot, to a depth of 3″ from the front of the plate.

8. Struck the 5½″ plate 1′ to the right of 2 vertical, and 7″ below 2 horizontal, the shell completely penetrated the plate and burst in the backing, the hole being filled with portions of shell. The diameter of the hole was 14″ × 14·3″; the plate was driven in 1·8″ in a length of 4′, and cracked from the bottom of the hole to the bottom of the plate, and was forced up from the centre plate 0·5″ in a length of 4′; started from backing 0·7″ at left side; bolt in top row of centre plate started 3″; outside baulk of timber backing driven out at the side 1·7″ and split through its thickness at the top, and the backing at point of explosion completely destroyed and fired. At the back, one vertical rib and angle-iron broken; inner skin and additional iron plates (riveted to back of skin) rent and bulged; depth of fracture and bulge 14″ over an area of 3′ × 3′; horizontal angle-iron along the top cracked and thrust out; washers more squeezed, and more rivets off.

13. Struck the 7½″ plate on 5 vertical, and 8″ above 2 horizontal; plate driven in 3·75″, and slight crack across indent. Back of plate showed a large seven-starred crack, fissures of cracks 0·2″ wide; considerable bulge of plate; adjoining rivets off. Major diameter of shot after firing, 13″.

EXTRACTS from the Report of the Special Committee on Iron, on the Experiment of the 17th March 1863.

The next round was from the Armstrong 300-pounder shunt gun, which was fired with a charge of 45 lbs., and a steel solid shot weighing 301 lbs. The shot struck the 7½″ plate on the backed part on a rib, with a velocity of 1293′ per second, making a hole 6½″ deep and 12·9″ diameter. The plate was driven in 1·3″ in 7′; a bolt started an inch, and the plate was slightly cracked from a bolt hole; a rib was broken; the skin of the target was bulged, and a good many rivets were broken; two of the iron hoops, by which the india-rubber washers were retained, and the fastenings of a shelf-piece, were broken. The shot, which was originally 14″ long, only set up 2″, and was unbroken.

The next round was a steel shell from the Armstromg 300-pounder; it was fired with the same charge as the last round, and with a bursting charge of 11 lbs. It struck the backed part of the 5½″ plate, went quite through the plate, bursting nearly through the skin, and set the wood backing on fire; broke a rib, and did general damage behind. Velocity of shell, 1318′.

The next round was a wrought-iron spherical shot, fired from the Armstrong 300-pounder shunt gun, with a charge of 45 lbs.; it struck the 7½″ plate on the unbacked part, made an indent of 3·7″ in depth, cracked and opened the back of the plate, and started several bolts. The shot was much compressed, and measured 13″ in its major-diameter after firing. The velocity was 1627′.

The steel solid shot fired from the 300-pounder shunt gun was excellent; it did not break up, but was "set up" about 2 ¼″, and cracked at the side and back; and, considering its great weight, it is decidedly the best steel shot which the Committee have yet seen.

(True extract.)

A. Harrison, Captain R. A., Secretary.

RECORD of all Trials at *Shoeburyness* of Armstrong Rifled 300-Pounder Guns against Iron Plates—*continued.*

Number of Round.	Nature of Ordnance.	Projectile.			Charge in Lbs.	Elevation.	Range in Yards.	Deflection.	Effects.			REMARKS.
		Nature.	Weight in Lbs.	Form.					Depth of Indent in Inches.	Diameter of Indent in Inches.	Bulge of Plate in Inches.	
27	300-pounder	Steel solid Shot.	301	Cylindrical. R. E.	45	20′	200	4 R.	Thro'	–	–	27. Struck at the junction of the centre and upper plates, at 4′ 4″ from the left edge of target, and on a bolt, penetrated the target, and made a hole 14½″ × 13″ in the armour plate. At the back, fragments of plate, backing, &c., driven through; large irregular hole, 2′ × 1′ 6″; general bulge of skin over 4′ 6″ × 3′ 6″; one rib smashed and driven back, 1′ 6″; ragged inner skin sticking out 1′; many adjoining rivet-heads off. The shot "set up" 1·93″. When the front armour plate was removed, the hole in the front of the backing was found to measure 12″ × 8″.
28	300-pounder	Cast-iron solid Shot.	lbs. ozs. 149 10	Spherical ″ 10·369 Diamr.	50	18′	200	Nil.	–	–	–	28. Struck at the junction of the upper and centre plates, at 3′ 6″ from right side of the target; penetrated to a depth of 11,″ and made a hole in the front of the target measuring 14″ × 11″; two through bolts broken, one at 15″ from point of impact; five inner armour-plate-bolts broken, and one driven in 3″; five rivets broken; a rib bulged out 2″ in a length of 4′, and another rib bent ½″ in 3′; considerable bulge of skin over a space of 3′ × 2′, and the skin opened ½″ at the junction of the plates; one angle-iron of rib broken. When the front armour plate was removed, the backing was found to have been affected for about 3′ 6″ on each side of the hole, being 2″ out of the plane at the greatest depth.
29	″	″	″	″	″	5	″	7½	–	–	–	29. Struck the lower plate 10″ from the right side and 8′ from the top, touching a bolt; made a hole in target 12″ diameter, penetrated to a depth of 12″, and shot broke up in hole; the upper right-hand corner of the plate, the sides measuring 11″ × 9″, was detached and was forced 4″ into the backing at the side next the hole; two inner armour-plate bolts and three rivets were broken; the skin was slightly bulged over a space of 2′ × 1′ 6″, and was cracked for a length of 12″, the crack being 0·6″ wide in the widest part; one angle-iron of rib broken, and the india-rubber washers of the through bolts much compressed.

These rounds were fired at the Chalmers' target, which was of the following construction:—

The target (13′ 4″ long by 10′ high) was composed of 3¾-inch armour plates, with a compound backing 10¾ inches thick, formed of horizontal layers of wood, and iron plates; behind this was a second armour plate 1¼ inch thick, with a cushion of timber 3¾ inches thick between it and the ⅝-inch plate forming the skin of the ship; the iron plates used in the backing, between the first and second armour plates, were ⅜ inch in thickness and 5 inches apart from centre to centre. The armour plates were secured to the skin by through bolts, 2¼ inches diameter, having stepped conical necks, and a square thread, with double nuts and elastic washers. A strong plate-iron buttress or counterfort, ¾ inch thick, was riveted on each end of the target, and a ⅜-inch plate on the top.

The target was fixed against one of the old Hawkshaw targets.

Admiralty, 1 June 1863.

EXTRACT from the Report of the Committee on the Experiment of the 27th April and 4th May 1863.

If now a comparison is made between the first round of spherical shot which was fired from the 300-pounder gun, and which struck both on this and the "Warrior" target (*see* p. 99, Report, 1862), at the junction of two plates, we find as follows:

The hole made in the front armour plate was nearly alike in both cases, viz.:—
"Warrior" target, 14″ × 12″.
Chalmers' target, 14″ × 11″.

The damage to the fastenings was:—
"Warrior" target—Two through-bolts broken.
Chalmers' target—Two through-bolts, five inner armour-plate bolts, and five rivets broken.

The damage to the skin and ribs was:—
"Warrior" target—Inner skin fractured and bulged in, and iron rib broken in two.
Chalmers' target—The skin opened at the junction of the plates, and was considerably bulged, two ribs bulged in.

This comparison being, in the opinion of the Committee, considerably in favour of the Chalmers' target, more especially as the charges used in these rounds were:—
"Warrior" target—40 lbs.
Chalmers' target—50 lbs.

The Committee do not consider that any comparison can be instituted between Round 29 of the trial of Chalmers' target and either Rounds 3 or 4 of the "Warrior" target (*see* p. 99, Report, 1862), as the former target was struck in an extremely weak spot, and the front armour plate was a decidedly bad one.

The solid steel shot fired from the 300-pounder gun completely penetrated the target; but the Committee have not taken this into consideration in the comparison which they have instituted between the two targets, as no shot of this nature or weight was ever fired against the original "Warrior" target. The Committee desire to call particular attention to the excellent quality of this steel shot, which was manufactured by Sir William Armstrong, and, considering its great weight, they regard it as one of the best shot they have yet seen.

(True extract.)

A. Harrison, Captain R. A., Secretary.

H. Houghton, pro Chief Clerk.

Appendix, No. 51.

App. No. 51. PROCEEDINGS for SPECIAL COMMITTEE ordered to Report upon the Expenses incurred by Mr. *Whitworth* in carrying out Experiments on behalf of Her Majesty's Government.

Colonel W. H. Hutchinson, President.

MEMBERS:

Captain Warton, Royal Artillery.

Mr. Anderson, Inspector of Machinery, Royal Arsenal.

THE members of the Committee were, by the directions of the President, to meet in London at the Rectory-house, Devonshire-square, at 10 A.M. on the 24th June 1858.

The letters connected with the subject on which they were ordered to report were read, viz., one from the War Office to the President, dated 12th June 1858, 81-w-65, one from the Secretary of the Lords of the Treasury to the Under Secretary of State for War, dated 2d June 1858, and one from the War Office to the President of the 19th June 1858, 81-w-71, enclosing a further statement of Mr. Whitworth's accounts.

The Committee examined all the accounts and arranged the method in which the statement to accompany their report should be drawn up. They settled to re-assemble at Manchester on the 1st July 1858.

The Committee accordingly met at Manchester, at the Queen's Hotel, at 9 A.M. on the 1st July 1858. They proceeded to Mr. Whitworth's manufactory, and endeavoured to obtain full information respecting his accounts; the value of Government property in his possession, and such other matters as they deemed might be of use to the Secretary of State for War.

The Committee found that only a portion of Mr. Whitworth's accounts had been transmitted from the War Office to the President. Their first object therefore was to obtain a full statement of the accounts to the end of May 1858, and of all monies paid to Mr. Whitworth on account, and then to embody the whole in such a manner that it might easily be run through and understood. Such a statement will be found in the Appendix (A.) It shows first the totals of the various items; secondly the classification of these totals under the several headings of Buildings, Materials, Labour, Machinery, &c.; and thirdly a short summary of the whole, presenting the state of the account up to the end of last May, and exhibiting a balance in favour of Mr. Whitworth, amounting to 4,018 *l.* 17 *s.* 11 *d.*

In order to verify the accounts, certain items were selected in all the various branches (as may be seen in Appendix (C.), and were investigated into in the most searching manner to the minutest particulars. The vouchers for the several payments, and the daily time book of the manufacturer were carefully examined, and were found to be most clear and satisfactory.

Appendix (B.) shows the first statement drawn up by the Committee from the accounts transmitted from the War Office to the President. From this statement it would appear that the sum of 8,315 *l.* 16 *s.* 2 *d.* is due to Mr. Whitworth. The Committee, however, in order to save time, beg to submit a fuller statement in Appendix (A.), representing what they consider to be the true state of the case, which shows that 4,018 *l.* 17 *s.* 11 *d.* is the amount due to Mr. Whitworth up to the 29th of May 1858. This sum they respectfully recommend shall be at once paid, as they feel quite satisfied respecting the justice and moderation of the charges.

The Committee then proceeded to consider various other questions referred to in the War Office letter of the 12th of June 1858. Firstly, with regard to the distinctness of the machinery specified in the accounts from Mr. Whitworth's own machinery; and, secondly, with respect to the question, how much of the machinery is really the property of Government.

While, in some particular instances, it is difficult to say where Government property begins and Mr. Whitworth's terminates, still, upon the whole, the line of demarcation, as pointed out by Mr. Whitworth, is clearly in favour of Government, for his accounts show many heavy expenses for which he has made no charge. As an instance, there is a highly-finished small cannon, cut spirally into three longitudinal sections. This cost upwards of 200 *l.*; but as, on trial, it proved useless, the item does not appear in the accounts. This expenditure being incurred in order to make a long course of experiments, it necessarily follows that much of what has been manufactured, though costing at first a large sum, is now comparatively of little value; indeed, only the value of old material.

There are three machines—an apparatus for boring rifles, one for testing gun barrels, and one for shaping large projectiles—which are complete in themselves, but which have been abandoned for other machines, or for other methods of accomplishing the same results. These machines, if sold, would not realise the quarter of their original cost,

cost, and instead of selling them as old materials, the Committee would recommend that they should be sent to the machinery repairing branch of the Royal Arsenal, where they will be of more value to the Government than if applied in any other way of which the Committee is cognisant.

There are three other machines of full value, or which are so considered, at the present moment, namely, one for turning musket barrels, another for boring barrels, and a third for rifling barrels, the value of the three being about 450 *l.* These machines will be found useful to Government if Mr. Whitworth's system is introduced into the service, or they might be sold for about the above sum to any one likely to use them in making Mr. Whitworth's rifles. Should, however, there be no such purchaser, then they would only be worth the price of old material; but it should always be borne in mind that they have been of great value and service in furnishing information which could only be obtained by experiment.

There is a third class of articles which have cost many hundreds sterling to produce, but which are at present of little value, even as old materials. They were made for experimental purposes; they have fulfilled those purposes, and are now only suitable for a museum. Appendix (D.) shows exactly what is Government property.

The Committee having obtained all the information they could expect from a first visit to Mr. Whitworth's office and works, proceeded to that gentleman's grounds (about three miles from Manchester), where the shed is erected in which his rifle experiments are conducted.

This brick building was examined in order to estimate as closely as possible what sum the materials would fetch if sold. The Committee, from all they have been able to ascertain respecting this building and other properties belonging to Government, think they would probably realise, if put up to auction, as follows, but the Committee cannot form a very accurate estimate:—

	£.	*s.*	*d.*
Iron castings - - - -	136	–	–
Brass ditto - - - -	25	–	–
Iron forgings - - -	12	–	–
Steel ditto - - - -	10	–	–
Stores and materials - -	20	–	–
Instruments - - - -	25	–	–
Shed - - - - -	500	–	–
TOTAL - - - £.	728	–	–

The shed is so admirably suited to the purpose for which it was designed, and cost so much in its erection, that the Committee wish respectfully to urge that it should not at present be disposed of, for there are several interesting and valuable experiments which Mr. Whitworth has not yet had time to carry out, and which, in their opinion, would throw great additional light on the whole subject of rifles, projectiles, and gunpowder, and which can only be conducted satisfactorily in such a place as the existing building. App. No. 51.

Should this suggestion meet with approval, the experiments alluded to could be effected by merely delaying the sale of the shed until the end of the summer of 1859, to which period Mr. Whitworth has no objection to its remaining on his grounds. The Committee would suggest that experiments should be made,—

1. In the qualities of different sorts of powder, tested by comparative elevation.

2. In the results obtained by different turns of spirals in barrels.

3. In the effects produced by different lengths of projectiles, and by different lengths of barrels.

4. In penetration through metal plates.

5. In trajectories through screens placed at intervals.

The cost of fully carrying out these experiments would probably be between 5,000 *l.* and 6,000 *l.*; but it is reasonable to expect that they will finally set at rest many important questions still pending. These experiments will also be most valuable as aids in solving various points on the subject of projectiles for heavy ordnance. As the past experiments have been conducted with great ability, and at a sacrifice of much time and money, it seems to the Committee that it would be most unadvisable to stop them at a moment when a comparatively small further outlay would enable them to be brought to a satisfactory conclusion.

Before terminating their report, the Committee wish to state that their labours at Manchester were much lessened by Mr. Whitworth's zealous assistance, who appeared most anxious that they should sift to the bottom every pecuniary transaction, and they beg leave to express their conviction that he has only charged to Government the expenses he has himself incurred and discharged; that so far from seeking any profit, that he has lost interest on monies which he has from time to time advanced, and that the country has had, and still has, the benefit of the services of the first mechanician of the day, who, regardless of his labour and time, and the expense of attending Committees, &c., has energetically endeavoured, by means of beautiful machinery, to solve a problem which can only be solved by the test of much experiment—"the true principle of rifling."

(signed) *W. W. Hutchinson*, Colonel,
President of Committee.

Queen's Hotel, Manchester,
3 July 1858.

Appendix, No. 52.

App. No 52.

CORRESPONDENCE relating to Rifled Cannon.

Sir, Manchester, 7 Sept. 1858.

I should feel much obliged if you would furnish me with particulars of the experiments made on the 31st ultimo with the 9-pounder and 6-pounder brass guns which I bored and rifled.

On the 1st instant, I addressed a letter to General Cator respecting the carriages and sights of these guns, and I am anxious to know the decision of the Committee.

I am, &c.
(signed) *Joseph Whitworth.*

Colonel W. H. Pickering, R. A.,
Royal Arsenal, Woolwich.

Sir, Woolwich, 9 Sept. 1858.

I have the honour to acknowledge the receipt of your letter of the 7th instant.

I will send to Shoeburyness for the reports of the practice which the Committee witnessed there on the 31st ultimo.

The letter which you addressed to General Cator, respecting carriages and sights, will be laid before the Committee to-morrow.

I have, &c.
(signed) *W. H. Pickering*, R. A.

J. Whitworth, Esq.,
Manchester.

(80—General No.—70.)

War Office,
Gentlemen, 20 Sept. 1858.

I am directed by Secretary Major General Peel to inform you, that the Special Committee on Rifled Cannon, under the presidency of Colonel Mitchell, R. A., have expressed a desire to visit, accompanied by the Inspector of Machinery at the Royal Arsenal, the establishments of your firm at Manchester; and I am to request that, should you entertain no objection, you will have the goodness to cause the necessary facilities to be afforded to the officers in question.

I am, &c.
(signed) *Hardinge.*

Messrs. J. Whitworth & Co.,
Manchester.

My Lord, Manchester, 21 Sept. 1858.

We beg to acknowledge your Lordship's letter (80—General No.—70) of the 20th instant, informing us that the Special Committee on Rifled Cannon, under the presidency of Colonel Mitchell, R. A., have expressed a desire to visit, accompanied by the Inspector of Machinery at the Royal Arsenal, our establishment; and, in reply, we beg to state that it will give us much pleasure to afford the necessary facilities, at any time that may be convenient to the Committee.

We have, &c.
(signed) *Joseph Whitworth & Co.*

The Right Hon.
Lord Viscount Hardinge,
War Office, S. W.

Castlestrange, Athleague,
Dear Sir, Ireland, 2 Oct. 1858.

Your note of the 26th ultimo followed me to this place, where I am on leave of absence; but before I left Shoeburyness, the new Committee on Rifled Cannon had settled to visit your establishment about the end of October. I find, however, since my arrival here, that I cannot leave just at that time; and I yesterday wrote to Sir W. Wiseman, who is acting as President in my absence, to see if it will suit the others to go to Manchester about the 20th, or 5th or 6th November; but as soon as anything is settled, we will let you know. We purpose going to Mr. Armstrong's first, so there will be plenty of time to communicate with you.

Yours, &c.
(signed) *W. H. Mitchell.*

Mr. Whitworth.

The fore-sight you sent me is not a good fit. I have applied for a proper carriage, and it will probably be ready at the end of this month or early in November.

Sir, Manchester, 14 October 1858.

I have to acknowledge the receipt of your letter of the 23d ultimo, in which you ask for a statement of my views on the subject of rifled cannon, and if I have any proposition to make. Absence from home has prevented me from sending an earlier reply.

For a general statement of my views on the subject, I beg to refer you to my report, addressed to Lord Panmure, dated 13th June 1857, a printed copy of which you would obtain at the War Office.

When I bored and rifled the howitzers and guns for the Government (the former nearly three years ago), I expected to have obtained valuable data, by their being submitted to a regular course of practice. This I hope will now be done, and that facts will be supplied, especially with regard to shell

shell practice, which will show exactly what is still required.

In my opinion it is wrong to use iron cast in solid masses, as at present, for large rifled guns: at the same time, I am fully convinced that rifled 68-pounders may be constructed strong enough to bear any requisite charge, without making them heavier than the present guns, and that their shot may be driven through 4-inch plates from considerable distances, and even through much thicker plates.

When the Committee favour me with a visit in Manchester, it will give me great pleasure to afford all the information in my power.

I am now making for myself a field-gun, so light that experiments may be made with it here; and I shall be happy to communicate the results to the Committee.

I am, &c.
(signed) *Joseph Whitworth.*

Lieut. Colonel Mitchell, R. A.,
President of the Rifled Cannon Committee.

(80—W.—135).

War Office, 30 October 1858.

Gentlemen,

I AM directed by Secretary Major General Peel to acknowledge the receipt of your letter of the 2d October, and in reply, I am to request that the preparation of the shells and shot ordered in the letter addressed to you from this office on the 1st October last may be suspended, as the Committee on Rifled Cannon have a sufficient supply in their possession, and it is not probable that any more will be required.

I am, &c.
(signed) *J. Bacon.*

Messrs. Whitworth & Co.,
Chorlton-street, Portland-street,
Manchester.

Mr. *Whitworth* to Sir *William Wiseman.*

(Extract.)

The Firs, 16 November 1858.

TO-DAY we send 20 solid shot with flat fronts for the 9-pounder, and 10 for the 32-pounder; also 50 of each size of lubricating wads, two parts tallow to one of wax, for further trial. If you should find the wads too thin for the 32-pounder, you might insert two.

I would remark that the solid shot of 9 lbs. weight are much too short for the bore. In determining the size I expected that shell would be generally used.

I shall be at Fenton's Hotel on Monday, as General Hutchinson has summoned the Rifle Committee for that day.

(signed) *Joseph Whitworth.*

Mr. *Whitworth* to Sir *William Wiseman.* App. No. 52.

(Extract.)

Stancliff Hall, 6 Dec. 1858.

THIS morning I have a letter from Captain Frazer, asking me if I can attend on Thursday. Could you give me the option of coming up to Shoeburyness on Friday or Saturday? I return to Manchester to-morrow.

(signed) *Joseph Whitworth.*

Mr. *Whitworth* to Sir *William Wiseman.*

The Firs, 10 Dec. 1858.

NOT having heard from you in reply to my note of the 6th instant, I am afraid you have sent your letter to Fenton's Hotel.

The meeting of the Enfield and Whitworth Committee was postponed to next Monday, so I am going to town to-morrow.

If you would like me to come down to Shoeburyness on Tuesday, I shall be glad to do so.

(signed) *Joseph Whitworth.*

Sir *William Wiseman* to Mr. *Whitworth.*

United Service Club,
13 December 1858.

THE moment I received your first letter, I answered it, directing it to Fenton's Hotel, as you told me you would be in town on the Thursday. I regret you did not receive it. To-morrow we shall be busy the whole day long; but if you will come on Wednesday, I will arrange to fire your 9-pounder.

Be good enough to let me know if you can come on that day, either by letter or telegraph.

(signed) *W. Wiseman.*

Mr. *Whitworth* to Sir *William Wiseman.*

14 December 1858.

I REGRET that a meeting of the Enfield and Whitworth Rifle Committee to-morrow will prevent my coming to Shoeburyness; but I will come on Thursday, unless I hear from you to the contrary.

(signed) *Joseph Whitworth.*

Mr. *Whitworth* to Sir *William Wiseman.*

Fenton's Hotel, 22 Dec. 1858.

THE proceedings of the Rifle Committee have continued to prevent me during my visits to London from coming to Shoeburyness, as I had very much wished. I shall, however, be ready to do so either next week or the week after.

The ten 14-lb. projectiles sent last week are for the 12-pounder gun, rifled for the Woolwich Select Committee to enable them to try experiments they were desirous of making in relation to the conversion of smooth-bore brass guns into rifled ones.

I hoped to have been able to see you before this, when I should have explained the matter to you personally.

(signed) *Joseph Whitworth.*

Appendix, No. 53.

App. No. 53.

REPORT of Messrs. *Penn, Field & Anderson,* on the Injury sustained to Mr. Whitworth's 5½-inch-bore Gun.

Sir, London, 11 April 1861.

In compliance with the instructions contained in your letter of the 27th February last, in which you express the desire of His Grace the Duke of Somerset, that we would examine one of Mr. Whitworth's guns, which is now lying at Woolwich in a damaged condition, and report as to the cause of the damage, and more particularly with regard to the quality of the metal of which the gun was made, we have now the honour to submit the following report:—

That, having carefully examined the gun in question at Her Majesty's Dockyard, Woolwich, we find that the injury done to this gun arises from a crack upon one side of the tube forming the bore; it is in the vicinity of the breach, and extends down the barrel about 33 inches, but the greatest opening is situated about 22 inches from the breach, as shown by a green line on the accompanying drawing.

The appearance of the interior of the bore in the locality where the chief strain seems to have been exerted, that is, in front of the powder charge, indicates where the fracture began, and probably extended thence backwards to the breach, under the action of firing, repeated, it may be, several times.

Comparing the appearance of the gun with the effects produced in other burst guns, we are led to the conclusion that the injury to this gun should be attributed to some accidental cause connected with the mode in which it was charged, and fired under conditions which threw an extraordinary strain upon the part that was first forced to yield. We consider that the injury has not arisen from any want of strength in the structure of the gun, which would appear to be more than sufficient for its legitimate work.

After making a careful examination of the gun itself, and, judging from the results of several experiments which have been made to elucidate the cause of the fracture, we have come to the conclusion that it has been caused by some of the projectiles fired having been at some distance from the powder at the moment of the explosion, instead of being as is always intended in close contact with the powder charge, so that an air space was left in the bore behind the projectile, which we consider to be sufficient to account for the injury, and it may also be observed that the experiments above alluded to show that when this is the case, the explosion is of such a highly percussive character, that the force of it actually indents the iron of the gun at the end of the projectile.

From the circumstance that the injury to this gun has not extended to the outside under such conditions of strain as must have been in operation, we think that it is still capable of being fired experimentally, and that it has, in fact, been fired since the injury was first done to the interior of the gun (probably before it was manifested at the breach). We would venture to suggest, that it would be a useful and interesting experiment to test still further the power of endurance of the gun, by firing it with the service charge, and ascertain its penetrating power, which, with the ordinary precautions, would not, under any circumstance, be attended with danger.

We have, &c.

(signed) *John Penn.*
Joshua Field.
J. Anderson.

W. G. Romaine, Esq.
&c. &c.

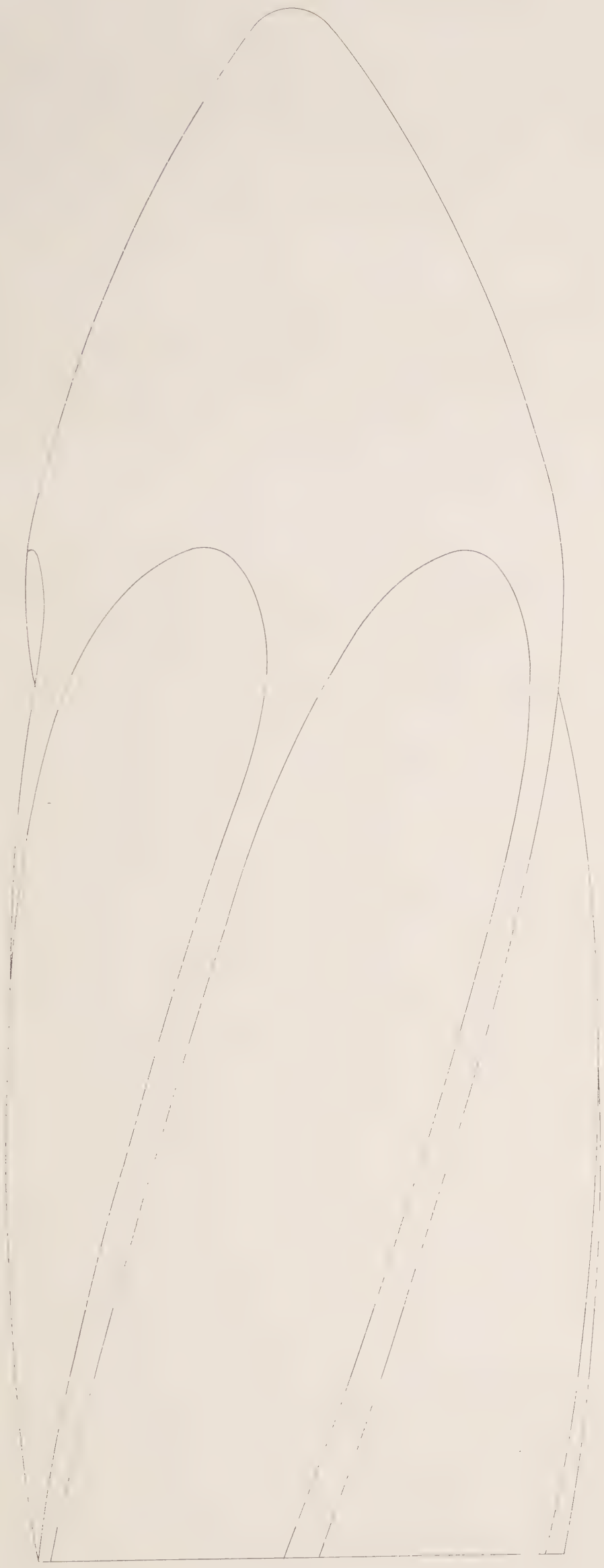
Appendix, No. 54.

App. No. 54.

Diagrams—Whitworth's Projectiles, Full Size. (*See opposite.*)

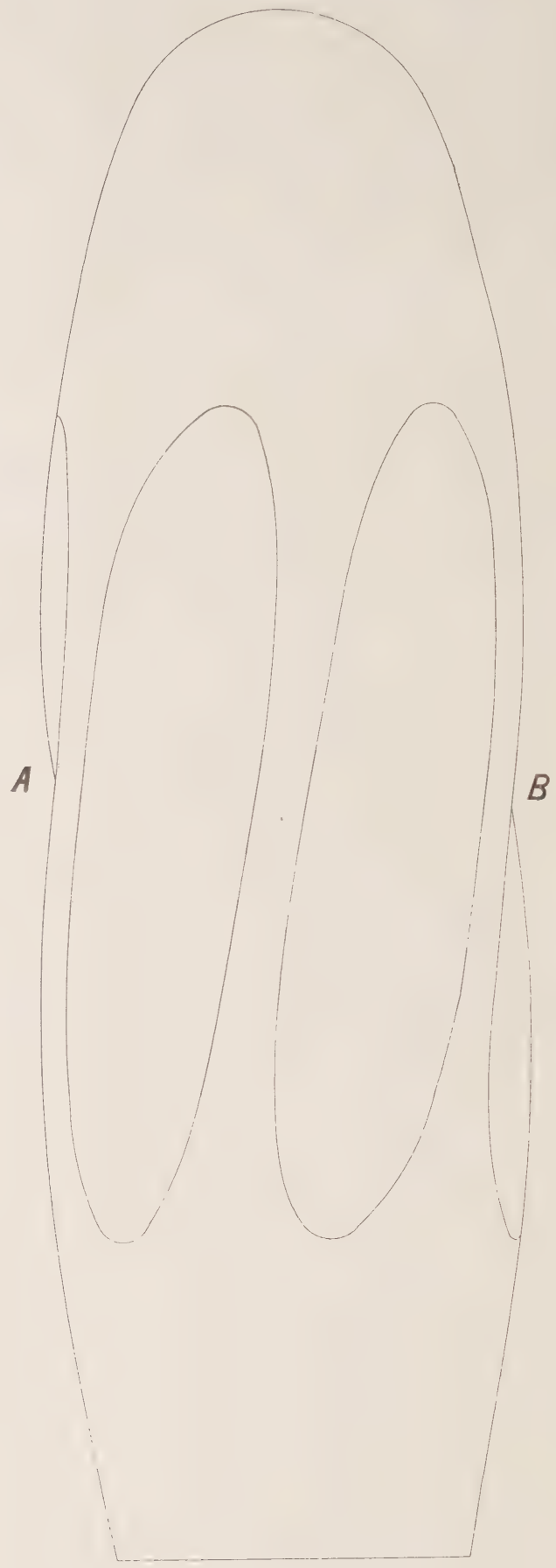
WHITWORTH PROJECTILES. (FULL SIZE.)

Hollow Shot fired in 1856 from a 24 Pr. How.r block, 4½ inches bore.

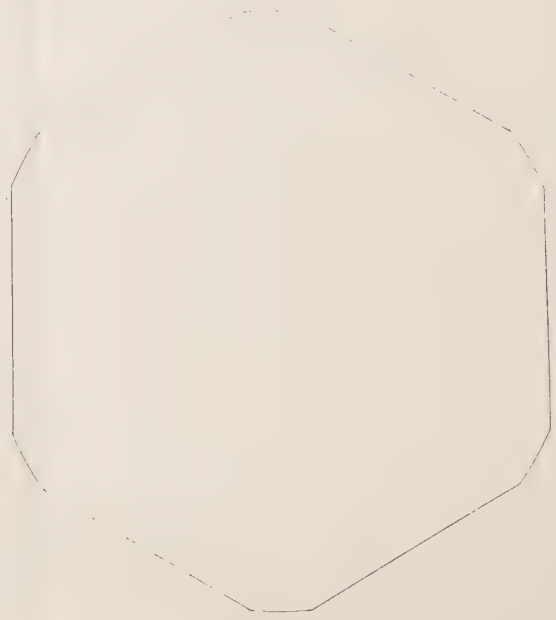


Plan of base.

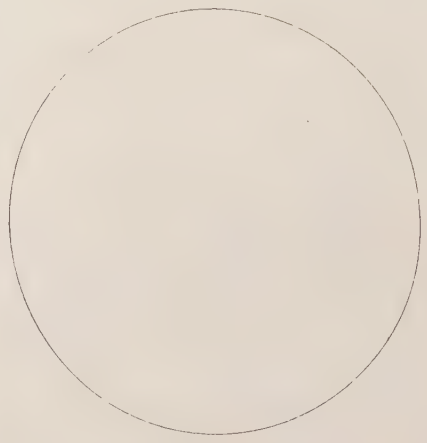
12 Pr. Solid Shot fired from a 12 Pr. B. L. Gun.



Section at A.B.



Plan of base.



Nº 487.—Ordered, by the House of Commons, to be printed, 23 July 1863

Henry Hansard, Printer.

LIST of ARMSTRONG GUNS of all Natures returned to *Woolwich*, and requiring Repair in the ROYAL GUN FACTORIES, made out up to 3 June 1863.

Nature.	Where Made.	Number of the Gun.	When Proved.	Where Issued.	Rounds Fired.	When Returned.	NATURE OF INJURY.	REMARKS.	Cost of Repair. £. s. d.
9-pr.	R.G.F.	26	- -	B batt. R. H. A. Dorchester.	50	22 Jan. 1863	Exterior crack at 3 inches from muzzle	Not yet repaired	—
12-pr.	R.G.F.	43	January 1860	E batt. 8th Brig.	Not reported	6 June 1861	Exterior crack in breech	Repaired, and serviceable	5 19 –
,,	R.G.F.	160	February 1860	Shorncliff	227	2 Jan. 1863	Cracks in the chase	Unserviceable; to be converted into new pattern short 12-pounder guns.	—
,,	R.G.F.	198	March 1860	Shorncliff	26	2 Jan. 1863	Coil behind trunnion shifted, and "A" tube broken	Not yet repaired	—
,,	R.G.F.	190	March 1860	Shorncliff	36	2 Jan. 1863	Lining shifted 15-hundredths of an inch	Unserviceable; to be converted into a sealed pattern gun	—
,,	R.G.F.	287	April 1860	Shorncliff	17	2 Jan. 1863	Coil behind trunnion split longitudinally	Filed and serviceable	– 6 –
,,	R.G.F.	315	April 1860	Shorncliff	200	2 Jan. 1863	Flaw in bore at 21 inches from muzzle	Filed, and now serviceable	– 5 6
,,	R.G.F.	240	March 1860	Fort Cumberland	Not reported	9 Sept. 1861	Flaw in bore at 37¾ to 39 inches	Repaired with new 1 A tube, and now serviceable	21 1 11½
,,	R.G.F.	222	March 1860	Fort Cumberland	Not reported	9 Sept. 1861	Bad flaw in bore at 57 inches (bad weld)	Unserviceable; to be new pattern short 12-pounder	—
,,	R.G.F.	286	April 1860	Shoeburyness	276	13 Feb. 1862	"A" tube cracked through at 6 inches from the muzzle	Repaired by lining, which failed at proof; lined again, and now serviceable.	33 3 9
,,	R.G.F.	119	January 1860	Shoeburyness	993	21 Nov. 1860	"A" tube cracked at 40 inches	Repaired, and serviceable	1 10 –
,,	R.G.F.	337	June 1860	Shoeburyness	479	4 Oct. 1861	Lining shifted, 15-hundredths of an inch	Not yet repaired	—
,,	R.G.F.	316	April 1860	K batt. 4th Brig.	Not reported	31 Dec. 1862	Lining in powder chamber cracked during 10 developing rounds.		
,,	R.G.F.	341	January 1861	E batt. 8th Brig.	Not reported	20 Feb. 1862	Lining in powder chamber cracked	Not yet repaired	—
			When Issued.						
20-pr.	R.G.F.	40	6 July 1861	Shoeburyness	372	14 July 1862	Lining split	This being a lined gun, was repaired with coiled tube, now serviceable.	30 10 6
40-pr.	E.O.C.	68	29 Aug. 1861	Shoeburyness	26	28 Oct. 1861	22 inches of muzzle blown off through carelessness in leaving drill shot in gun.	Repaired with new chase, and serviceable	80 10 –
,,	E.O.C.	107	6 Feb. 1861	Devonport	Not reported	26 Aug. 1861	Flaw in bore at 49½ inches from muzzle	Filed, and serviceable	– 11 3
,,	E.O.C.	131	26 July 1861	Her Majesty's Ship "Doris."	29	19 Jan. 1863	Flaw in bore at 46 inches from muzzle	Filed, and serviceable	– 15 –
,,	E.O.C.	136	5 June 1861	Shoeburyness	17	23 Nov. 1861	Flaw in bore at 17½ inches from muzzle	Filed, and now serviceable	– 12 8
,,	E.O.C.	334	11 Sept. 1862	Fort Cumberland	137	19 Jan. 1863	Flaw in breech end of bore	Filed, and now serviceable	– 12 9
,,	E.O.C.	159	26 July 1861	Her Majesty's Ship "Queen."	Not reported	15 April 1862	Flaw in powder chamber	Repaired with short bouch, and serviceable	5 6 –
,,	E.O.C.	167	27 Nov. 1860	Portsmouth	671	18 July 1862	Coil in front of trunnion shifted, 15hundredths of an inch	Repaired with new coil, and serviceable	9 10 7
,,	E.O.C.	195	27 Nov. 1861	Portsmouth	244	18 July 1862	Rifling damaged by shell	Lined throughout, and serviceable	39 11 9¼
,,	E.O.C.	503	- -	Shoeburyness	5	30 Oct. 1862	"A" tube cracked	Lined throughout, and used for proving vent pieces	37 14 –
110-pr.	R.G.F.	13	- -	Shoeburyness	294	16 July 1861	Rifling damaged by shell, and flaw in powder chamber	Repaired, and now serviceable	93 2 1½
,,	R.G.F.	70	8 May 1861	Her Majesty's Ship "Stork."	81	30 Dec. 1861	Flaws in powder chamber	Repaired with coil barrel, and now serviceable	40 8 9
,,	R.G.F.	91	30 April 1861	Shoeburyness	84	31 Dec. 1861	Flaws in powder chamber	Repaired with coil barrel, and now serviceable	44 18 –
,,	R.G.F.	144	15 July 1861	Shoeburyness	325	4 June 1862	Crack at slot hole	Repaired with D and E coil	43 10 11¾
,,	R.G.F.	33	8 April 1861	Her Majesty's Ship "Mersey."	57	18 Aug. 1862	Flaws in powder chamber	Not yet repaired	—
,,	R.G.F.	211	3 Oct. 1861	Shoeburyness	128	Dec. 1862	Expansion of powder chamber	Not yet repaired	—
,,	R.G.F.	68	27 March 1861	Shoeburyness	388	24 Aug. 1861	Flaws in powder chamber	Not yet repaired	—
,,	R.G.F.	17	7 March 1861	Her Majesty's Ship "Hero."	200	29 Nov. 1861	Crack in breech piece	Not repaired; used for proving vent pieces	—
,,	R.G.F.	91	30 April 1861	Shoeburyness	81	31 Dec. 1861	Flaws in powder chamber	Not yet repaired	—

App. No. 55.

LIST of ARMSTRONG GUNS rendered Unserviceable by proving Vent Pieces.

Nature.	Where made.	Number of the Gun.	Proof Charge = Two Service Charges; Proof Rounds fired.	
6-pr.	R. G. F.	36	9	
9-pr.	- -	None, rendered unserviceable.		
12-pr.	- -	None, rendered unserviceable.		
20-pr.	- -	None, rendered unserviceable.		
40-pr.	E. O. C.	17	460	
,,	E. O. C.	147	369	
,,	E. O. C.	166	1,050	
,,	E. O. C.	184	144	
,,	E. O. C.	503	135	
110-pr.	R. G. F.	17	15	Cracked after 200 rounds, on board Her Majesty's ship "Hero," and not repaired.
,,	R. G. F.	135	309	
,,	R. G. F.	657	247	
,,	R. G. F.	663	357	
,,	R. G. F.	683	261	
,,	E. O. C.	28	313	Previously tested with 100 rounds for endurance with shot, up to 1,000 lb.
,,	E. O. C.	143	27	
,,	E. O. C.	191	119	

ARMSTRONG GUNS *issued* for Service, showing where made.

February 1863.

Nature of Gun.	Number issued, E. O. C. Make.	Number issued, R. G. F. Make.	Total Number Issued.
110-pounders - -	179	620	799
40 ,, - -	535	106	641
20 ,, L. S. -	9	16	25
20 ,, S. S. -	1	231	232
12 ,, L. S. -	79	313	392
12 ,, S. S. -	—	178	178
9 ,, - -	—	66	66
6 ,, - -	—	37	37
GRAND TOTAL - -	803	1,567	2,370

Appendix No. 56.

App. No. 56. DIAGRAMS delivered in by Sir *William Armstrong*, 8 June 1863.—(*See opposite*).

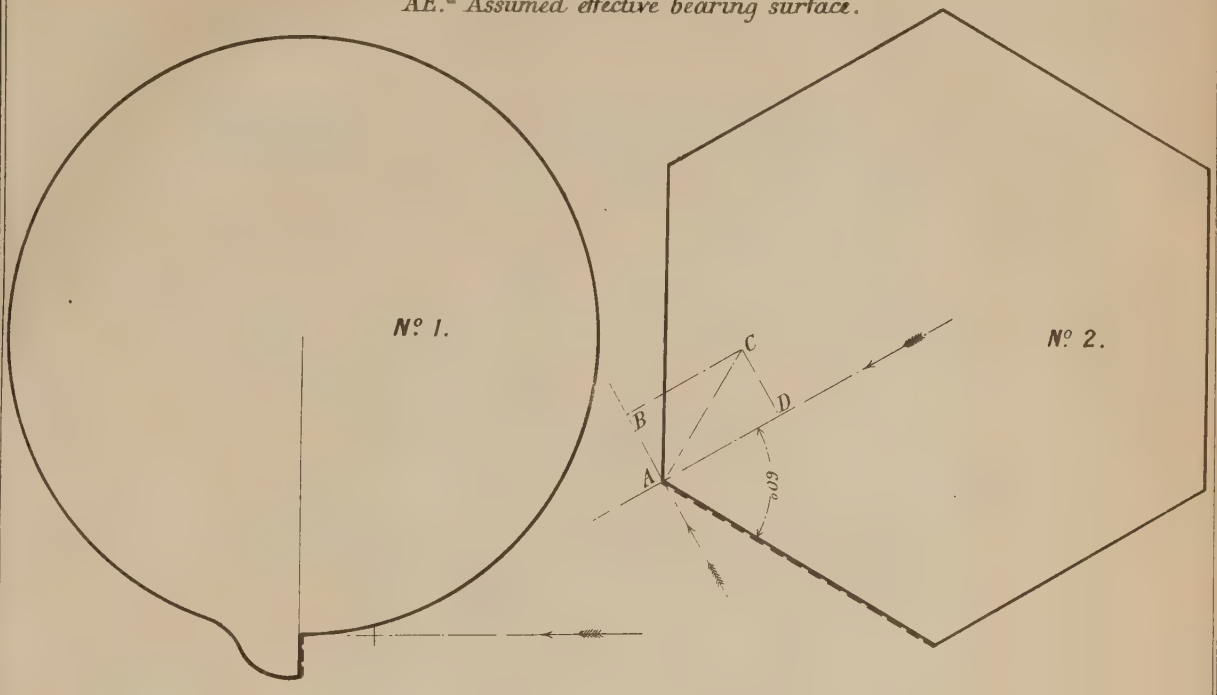
Letters of Reference

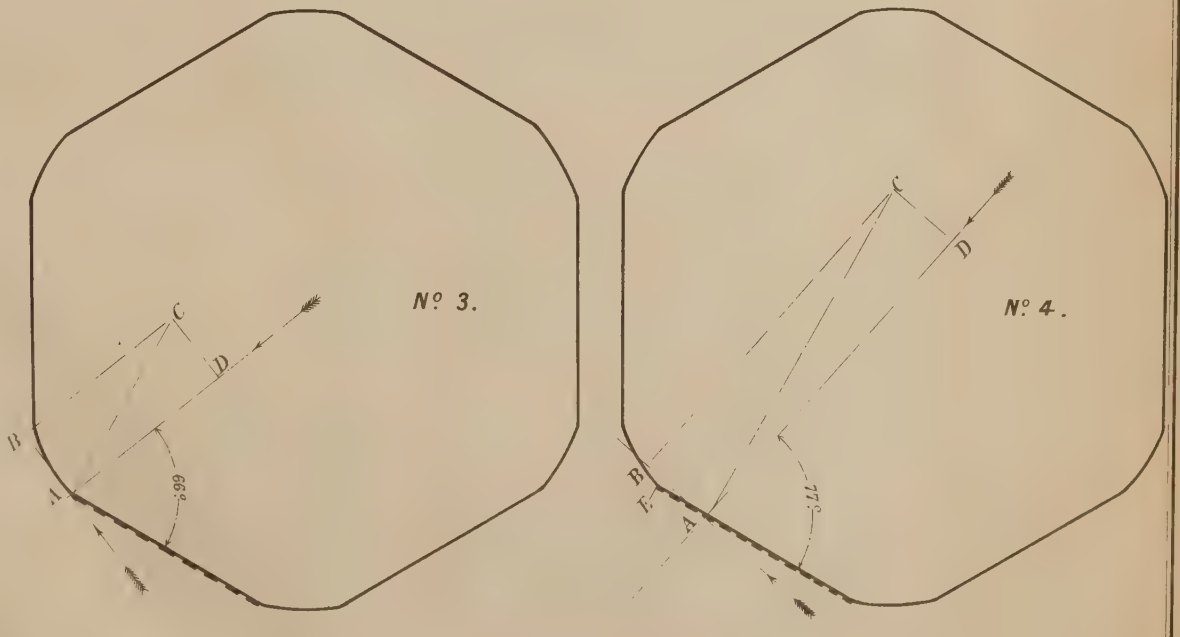
AB.- Tangential pressure.

AD.- Outward thrust.

AC.- Normal pressure on face.

AE.- Assumed effective bearing surface.





Numerical Values.

No. 1.

Tangential pressure -1.
Normal pressure on face 1.

No. 2.

Tangential pressure -1.
Normal pressure on face -2.05.

No. 3.

Tangential pressure 1.
Normal pressure on face -2.55.

No. 4.

Tangential pressure - 1.
Normal pressure on face -4.55
Mean pressure on surface A E -3.55.

No 487.—Ordered, by the House of Commons, to be printed, 23 July 1863

Appendix, No. 57.

PAPERS furnished by *Westley Richards*, Esq., 11 June 1863. App. No. 57.

(A.)

QUESTIONS to be Determined by COMPARATIVE EXPERIMENTS.

Rifling - -	The best principle of rifling. „ depth of grooving. „ spiral for accuracy at extreme range. „ spiral for high initial velocity and short ranges.
Powder - -	The best relative weight of projectile and powder for accuracy and extreme range. The best relative weight of projectile for high initial velocity. „ position for igniting the charge. „ quality of powder.
Projectile -	The best length of projectile for accuracy at extreme ranges. „ length of projectile for high initial velocities. „ form of projectile. „ material for projectile.
Weight of Gun	The best relative weight of gun to projectile for obtaining the greatest accuracy and the greatest range. The best relative weight of gun for obtaining the highest initial velocities.
Length of Bore	The best length of bore in diameters, for accuracy and range. The best length of bore in diameter, for initial velocities. The best relative length of bore to length of projectile, beginning with the sphere, and going up to the extreme length, which may be called three diameters.

(B.)

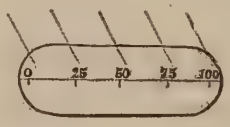
MODE of TESTING the VALUE of a GUN.

For a truly proportioned Gun.

	Marks.
Lowest angle of elevation - - - - - -	150
Accuracy at long ranges - - - - - - -	100
Rapidity of loading - - - - - - - -	150
Freedom from fouling - - - - - - -	150
Durability, and simplicity of arrangement, if a breech-loader	100
Projectile.—Its cheapness, and freedom from liability to injury on service or in store - - - - - -	100
Initial velocity - - - - - - - - -	150
Destructive powers against iron plates at long ranges - -	100
	1,000

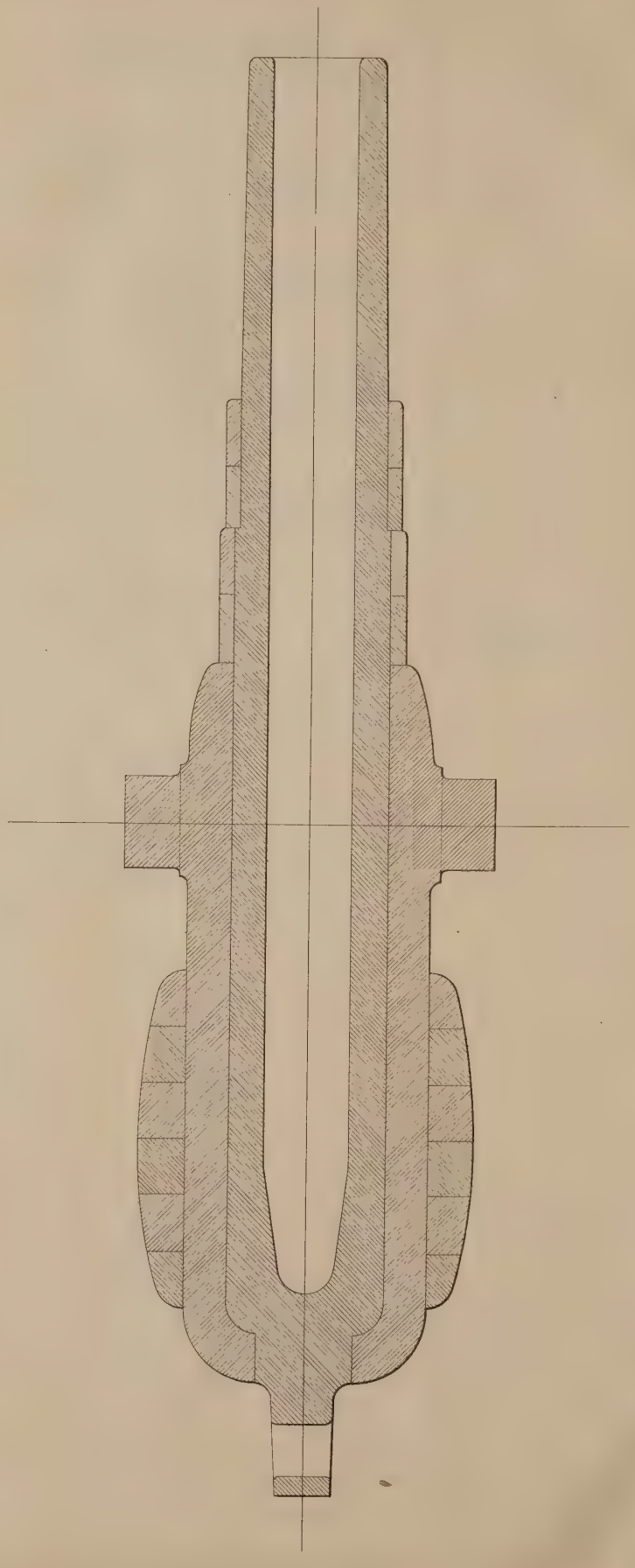
App. No. 57.

(C.)

Comparison between the Armstrong System of Rifling and Projectile, and the Whitworth System.	Description of a truly proportioned 90-pounder Gun.	
	Armstrong System.	Whitworth System.
Weight of gun	116 cwt.	116 cwt.
Relative weight of gun to projectile	145 to 1	145 to 1
Weight of projectile	90 lbs.	90 lbs.
Material of which projectile is made	—	—
Weight of powder	15 lbs.	15 lbs.
Description of powder	—	—
Relative weight of projectile to powder	6 to 1	6 to 1
Length of projectile in diameters	$2\frac{3}{4}$	$2\frac{3}{4}$
Length of bore in calibres	26	26
Relative length of bore to length of projectile	—	—
Bore of gun	5·2	5·2
Pitch of rifling	—	—
Depth of grooves 	Armstrong system.	Whitworth system.
Position of igniting powder	0	0

BLAKELY'S STEEL 200 PR.

Offered to the English Government Novr. 17th. 1860.

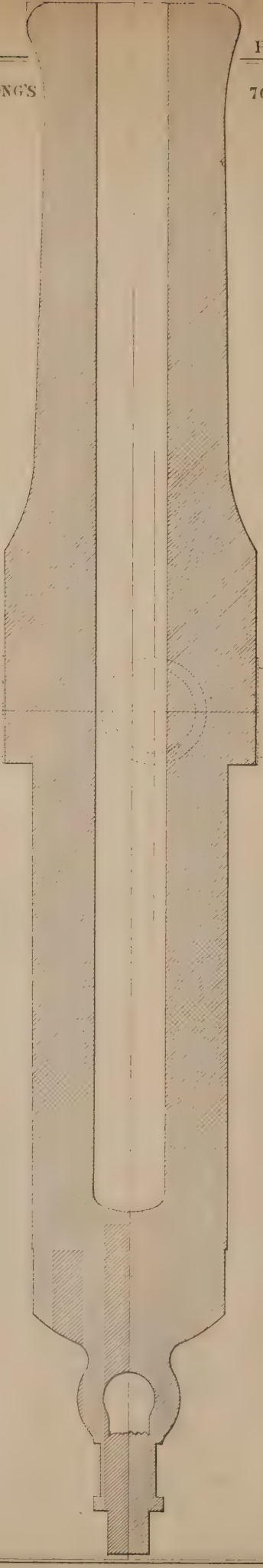


Nº 487.—Ordered, by the House of Commons, to be printed, 23 July 1863.

Henry Hansard, Printer.

BLOCK FOR SIR W. ARMSTRONG'S
Condemned in

70 Pr. NAVAL GUN 1859-60.
1860 after trial.



Nº 487.—Ordered, by the House of Commons, to be printed, 23 July 1863

Henry Hansard, Printer

Appendix, No. 58.

PAPER delivered in by Captain *A. T. Blakely*, 18 June 1863. App. No. 58.

THE BLAKELY CANNON IN 1855.

TRIAL OF STRENGTH BY ORDNANCE SELECT COMMITTEE.

RESULTS of a Comparative Trial made at Woolwich and Shoeburyness by order of the Ordnance Select Committee, 1855–1856, between a cast-iron service gun, a brass service gun, and one of Captain Blakely's built-up guns, all 9-pounders. They were all fired as follows:

2	rounds with	8	lbs. of powder,	2	shot,	1	wad.
16	„	3	„	1	„	1	„
26	„	4	„	1	„	1	„
5	„	5	„	1	„	1	„
5	„	5	„	2	„	1	„
110	„	6	„	2	„	1	„

Here the cast-iron gun burst. The brass gun stood with the same charge 64 rounds more than the cast-iron one, but it then became unserviceable. Captain Blakely's was fired 208 rounds more than the cast-iron gun, and 144 more than the brass gun, and *being then still perfectly uninjured*, the charge was gradually increased as follows:

1	round with	6	lbs. of powder,	3	shot,	1	wad.
1	„	6	„	4	„	1	„
1	„	6	„	5	„	1	„
1	„	6	„	6	„	1	„
1	„	6	„	7	„	1	„
1	„	6	„	8	„	1	„
158	„	6	„	and as many shot as the gun would hold.			

The cast-iron gun - fired 351 shot.
The brass gun - „ 479 „
And Captain Blakely's „ 2,389 „ or 7 times as many as the cast-iron gun, and 5 times as many as the brass gun.

Appendix, No. 58 *a*.

DRAWINGS delivered in by Captain *A. T. Blakely*, 18 June 1863.—*(See opposite.)* App. No 58 *a*.

Appendix, No. 58 *b*.

App. No. 58 *b*.

A.D. 1855.—No. 431.*

ORDNANCE.—BLAKELY'S DISCLAIMER AND MEMORANDUM OF ALTERATION.

Filed 31st March 1859.

In the matter of a Patent granted to Alexander Theophilus Blakely, of Little Ryder-street, St. James', in the County of Middlesex, Captain of the Royal Artillery, for his invention of "Improvements in Ordnance," bearing date the Twenty-seventh day of February, One thousand eight hundred and fifty-five.

Disclaimer and Memorandum of Alteration proposed to be entered by the said Alexander Theophilus Blakely, pursuant to the Statutes in that case made and provided.

To all to whom these presents shall come, I, Alexander Theophilus Blakely, formerly of Little Ryder Street, St. James', in the County of Middlesex, Captain of the Royal Artillery, send greeting:

Whereas by Letters Patent bearing date the Twenty-seventh day of February, One thousand eight hundred and fifty-five, Her present Majesty Queen Victoria did grant unto me, my executors, administrators, and assigns, the sole use, benefit, and advantage of my Invention of "Improvements in Ordnance:" And whereas a Specification of the same was duly filed in the Great Seal Patent Office on the Twenty-third day of August, One thousand eight hundred and fifty-five: And whereas also the stamp fees payable before the expiration of the third year have been duly paid, and the certificate thereof obtained: And whereas since the filing of the said Specification I have discovered that certain terms employed to express part of my said invention are too extensive, so as to be capable of being construed to embrace other previous discoveries; for which reason I am desirous of more clearly defining the nature, and thereby limiting the extent of my invention, by the introduction of the words "*a method of*" between the words, "The improvements relate first to" and "forming guns," &c.; also and for the same reason I am desirous of introducing the words following: "*but I do not claim as my "Invention the method of forming guns or cannon by the application of collars or rings, "heated and shrunk upon a cylindrical inner tube, save and except when the internal "diameters of such collars or rings are previously to being heated so much smaller than the "external diameter of the inner tube on which they are shrunk, that after being cooled, the "outer casing, formed by the rings or collars, is in a state of tension or permanent strain, "similar to that produced when the rings or collars are forced upon a conical surface as "before described, and the inner tube is in both cases similiarly compressed*" at the end of the first paragraph. At the beginning of the next paragraph, I propose to omit the words, "Secondly, the improvements consist in," and to introduce the following in lieu thereof, "*a like effect may be produced by.*" For the word "Thirdly" at the beginning of the next paragraph, I propose to substitute the word "*Secondly;*" and in the body of the Specification, when describing Figure 5, I wish to introduce the words, "*but to which I make no claim,*" so as to follow the words, "by which the parts are retained in position;" and at the end of the same paragraph I also desire to introduce the words, "*to do so, however, forms no part of my Invention to which I lay claim;*" and having also ascertained that the parts of the Specification embraced under the fourth, fifth, and sixth heads of the invention do not possess sufficient utility, and are not in all respects new, I am further desirous of disclaiming all the parts of the Specification included in such fourth, fifth, and sixth heads, and the description of the same as contained in the body of the said Specification, and the Specification so altered will then read as follows:—

Now know ye, that I, the said Alexander Theophilus Blakely, do hereby declare the nature of the said invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement thereof, that is to say:—

The improvements relate, first, to *a method of* forming guns with an internal tube or cylinder of cast iron or steel inclosed in a casing of wrought iron or steel. I sometimes form

Note—The words in Italics are inserted in red ink in the original.

To face page 535.

FIG. 8.

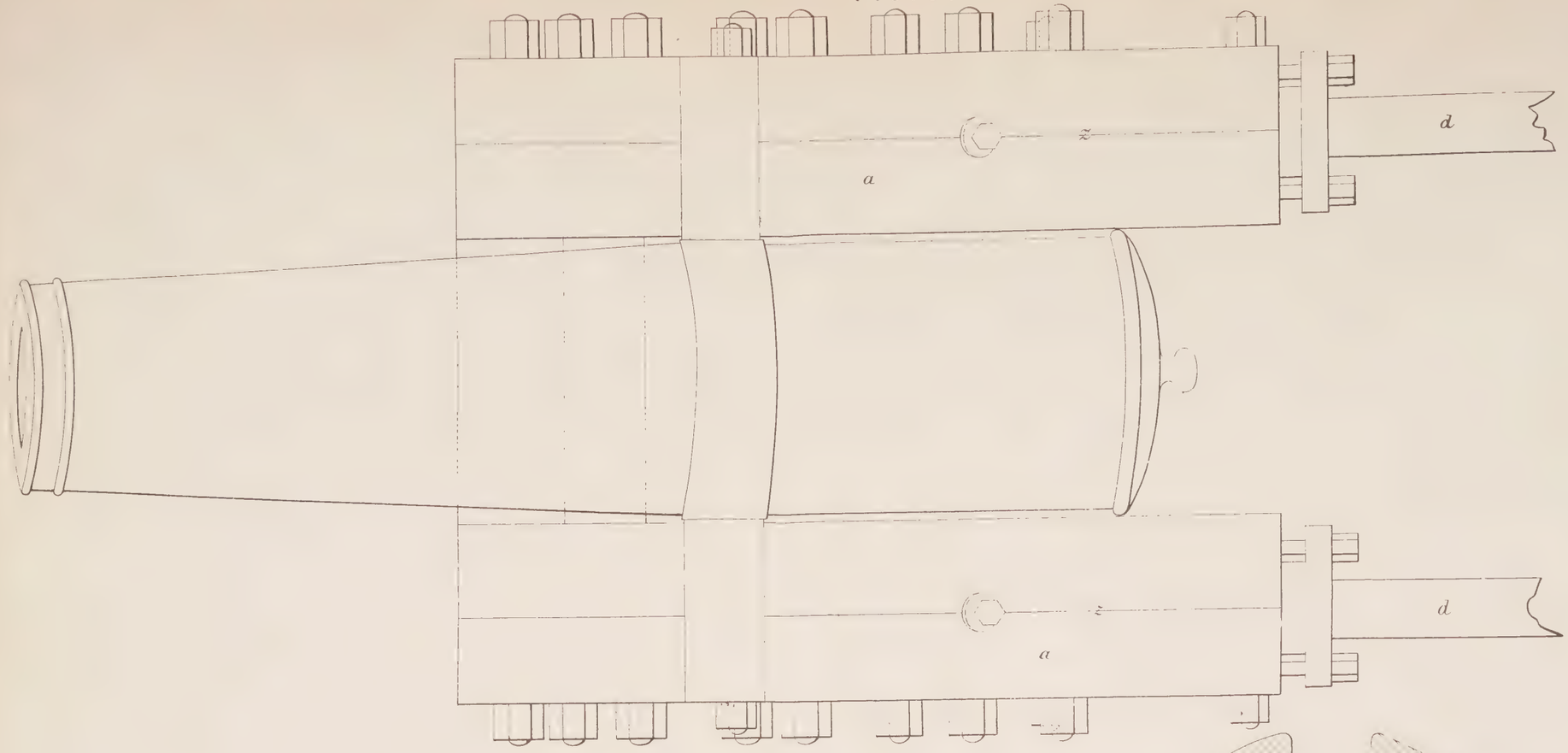


FIG. 10.

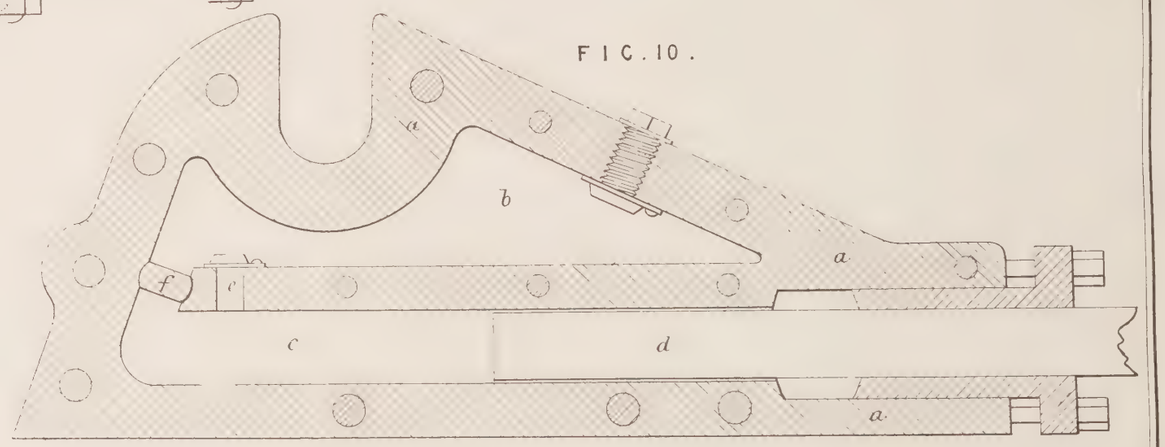


FIG. 9.

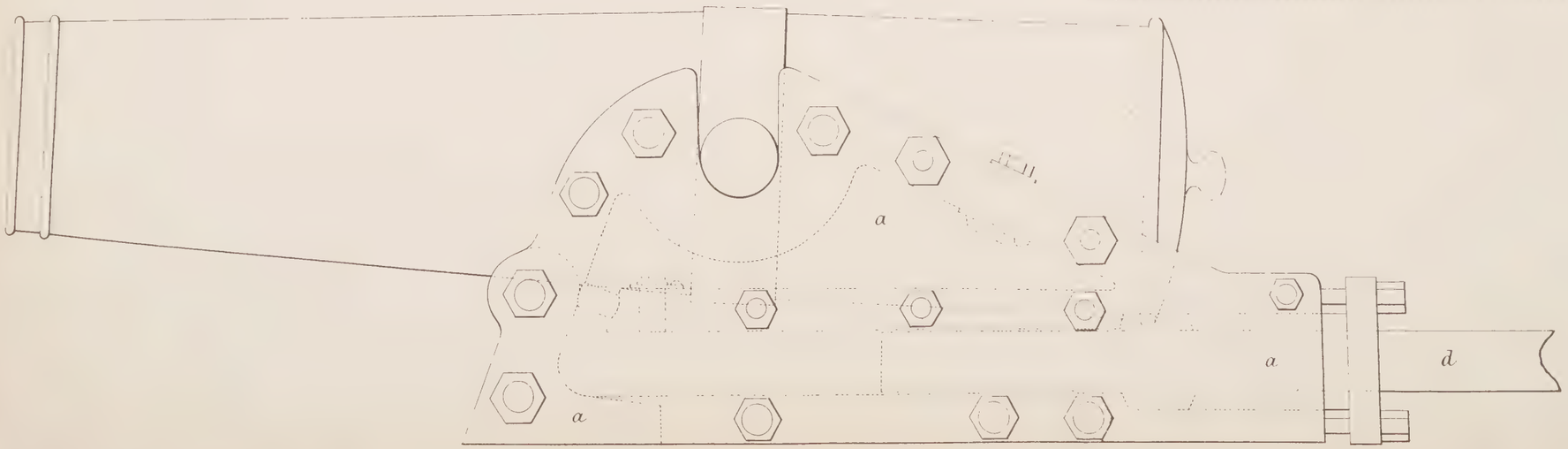


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FIG. 2.

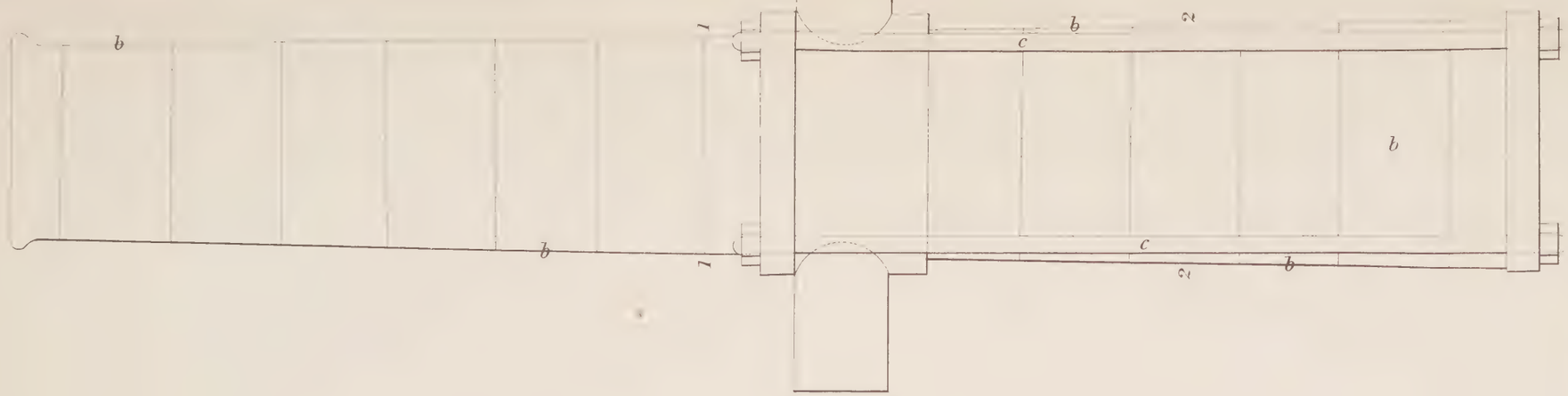


FIG. 4.

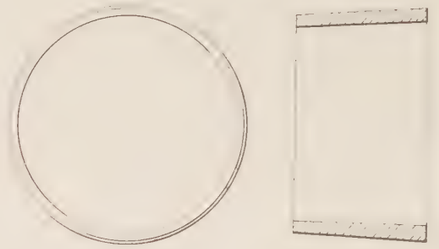


FIG. 1.

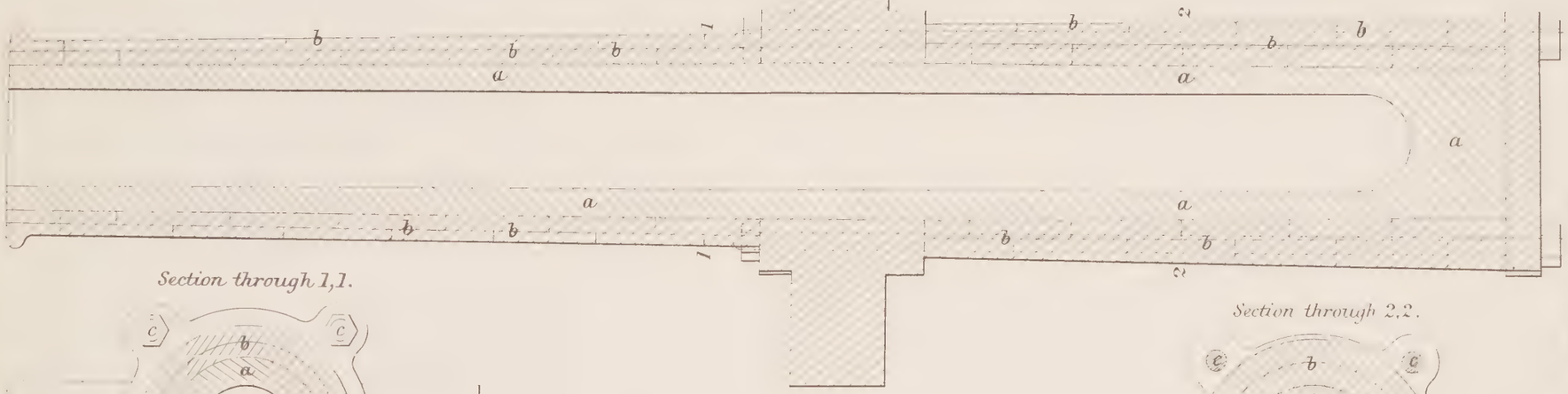
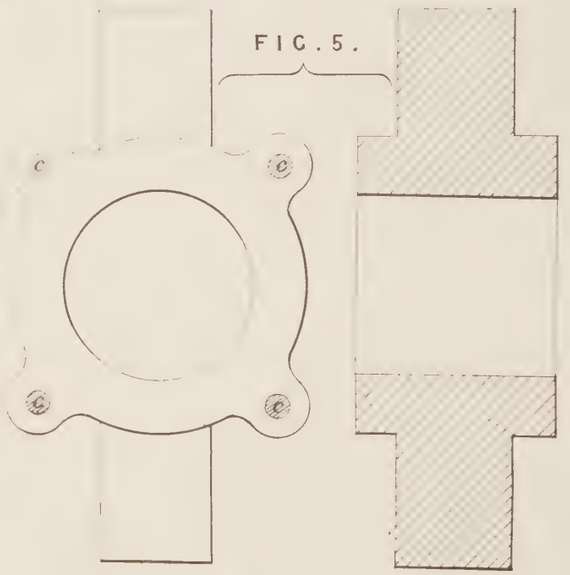
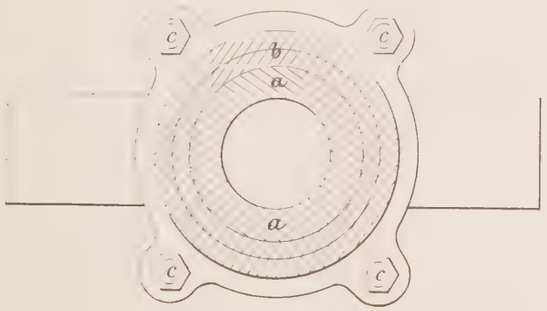


FIG. 5.



Section through 1,1.



Section through 2,2.

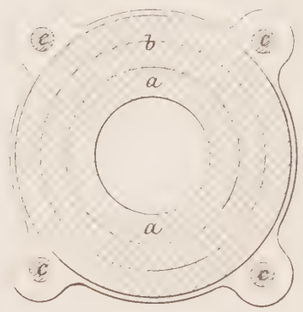


FIG. 6.

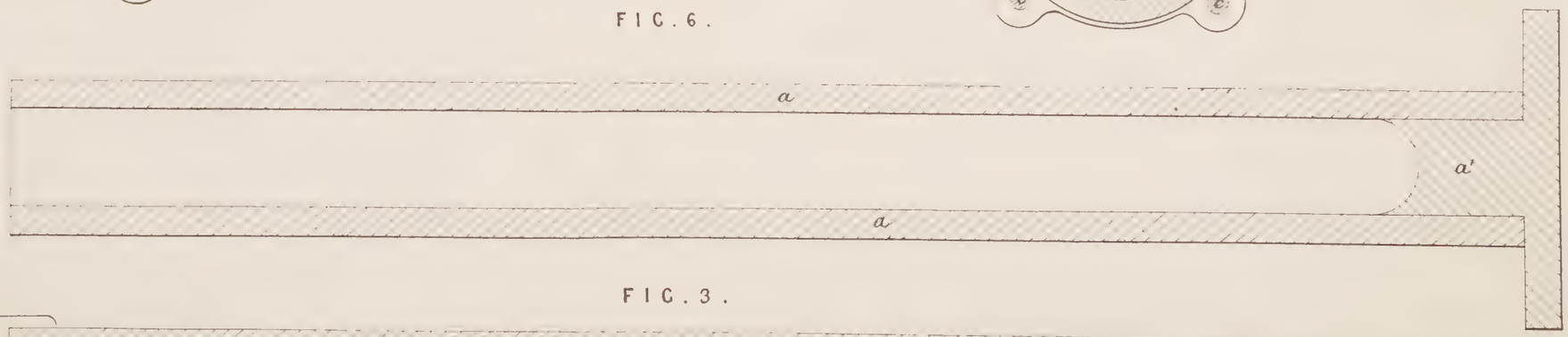
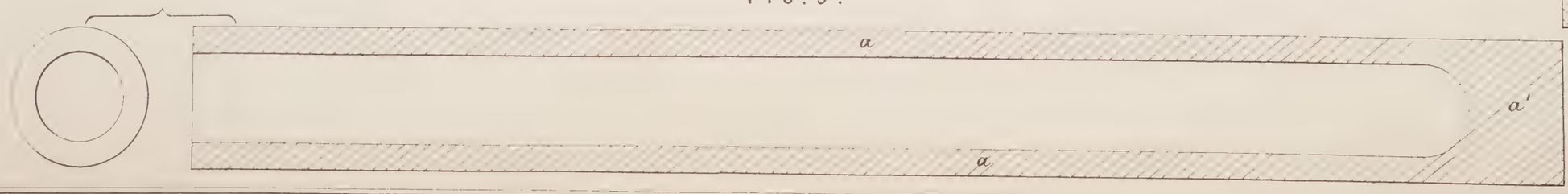


FIG. 3.



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form the outer surface of the inner tube somewhat conical, the greatest diameter being just in front of the trunnions and tapering both ways, and apply the outer casing in the form of collars or rings driven thereon: and in some cases I apply two or more layers of such rings, according to the strength sought to be obtained, the trunnions being of one piece with one of the rings. The outer casing may, however, be applied in the form of collars or rings, heated and shrunk upon the cylindrical surface of the inner cylinder or tube; *but I do not claim as my Invention the method of forming guns or cannon by the application of collars or rings, heated and shrunk upon a cylindrical inner tube, save and except when the internal diameters of such collars or rings are, previously to being heated, so much smaller than the external diameter of the inner tube on which they are shrunk, that after being cooled, the outer casing formed by the rings or collars is in a state of tension or permanent strain, similar to that produced when the rings or collars are forced upon a conical surface, as before described, and the inner tube is in both cases similarly compressed;* ~~Secondly, the improvements consist in~~ *a like effect may be produced by* forming heavy ordnance, especially rifled guns or sea-service mortars with an internal tube or cylinder (formed by casting and boring in the usual manner) upon which are cast rings of cast iron in one or more layers. When in several layers, the joints of the rings should "break band."

~~Thirdly,~~ *Secondly*, the improvements relate to strengthening old guns, or guns made according to other arrangements, by the application of external metal rings or coils of iron, as referred to under the first head of the improvements.

~~Fourthly, the improvements relate to employing the friction produced by the passage of oil or other fluids through a small passage in combination with the use of compressed air as applied to gun carriages for the purpose of moderating the recoil of the gun carried thereby. The gun carriage is formed with a cylinder or chamber to receive a piston, the rod of which is connected to some suitable abutment, and this cylinder is capable of communication through a small passage closed by a valve with another cylinder or chamber containing compressed air. When the gun is fired, the piston will act as an abutment to force the fluid from the cylinder containing it through the small passage to the air chamber, when the compressed air will serve to moderate the recoil, whilst the valve in the small passage, by closing against the return of the fluid, will prevent a rebound. Another valve or a tap is employed to open a communication between the air chamber and the cylinder, by which the fluid therein may be permitted to return and effect the running up of the carriage when desired.~~

~~Fifthly, my improvements relate to moderating the recoil of mortars when being fired, by the application thereto of the system embraced by the fourth head of the Invention.~~

~~Sixthly, my improvements relate to the application, when forming guns of separate layers or thicknesses of metal, of sheets or layers of lead or other soft metal, between such separate layers or thicknesses, for the purpose of insuring close contact.~~

But that my said Invention may be fully understood and readily carried into effect, I will proceed to describe the Drawings annexed.

Description of the Drawings.

Figure 1 shows a sectional view, and Figure 2 an external view of a gun arranged according to the first part of my improvements; Figure 3 shows the internal core separately; Figure 4 shows two views of one of the rings; and Figure 5, two views of the ring upon which the trunnions are formed; *a*, *a*, is the internal tube or cylinder of cast iron or steel, and which receives the charge; *b*, *b*. are a series of collars or rings, which are shrunk or driven upon the outer surface of the inner cylinder. There may be one or several series of such collars or rings, but when there are several layers, they should be applied so as to break joint as shown, and when applied they, with the internal cylinder, form one combined mass of metal, to resist the force of the charge when firing. The trunnions are formed on or affixed to one of the collars or rings, as shown by Figure 5: *c*, *c*, are rods formed with screws at their ends for nuts, by which the parts are retained in position, *but to which I make no claim;* guns thus formed of several parts may be either put together and transported as a whole, or they may be transported in separate pieces, and put together as required, by which great facility will be obtained for transport, especially with heavy guns. In these figures I have shown the end a^1 of the cylinder or tube formed as part of that cylinder; I do not, however, confine myself to that arrangement, and in some cases I form that part separately, as shown by Figure 6; *to do so, however, forms no part of my Invention to which I lay claim.* In place of forming the outer casing of separate collars or rings, I sometimes form such outer casing of wire or rod wound spirally in one or more layers around the inner cylinder or tube. When the guns are formed in several parts to be put together separately, then the internal cylinder may for the time be shrunk somewhat by the application thereto of any suitable freezing mixture, or the external rings may be caused to expand by heat, previous to being applied to the internal cylinder, and then shrunk thereon.

I have not thought it necessary to give any specific direction for casting metal upon the surface of internal cylinders or cores for the purpose of strengthening them, as I proceed by simply forming a mould of the figure of such ring, and then have applied the internal cylinder therein as a core. I pour the fluid metal into the space around, as is well understood by persons accustomed to casting in metal.

App. No. 58 b.

Old guns, or guns made according to other arrangements, may be strengthened by the application of external rings, or coils of wire, or bars of iron or steel, as described in respect to the first part of the invention.

~~Figure 8 shows a plan, and Figure 9 a side view, of a gun with a carriage constructed according to the fourth part of my improvements. Figure 10 shows a section through one cheek of the carriage. a, a, are the side frames of the gun carriage, each of which is formed with a chamber b for compressed air, which is supplied through the opening b'; c is a cylinder, and d a piston working therein. The rod of this piston is connected to some suitable abutment, and when the gun is fired the oil or other fluid contained therein will be forced through the valve passage into the air chamber b, the air in which will serve to moderate the recoil, and the closing of such valve will prevent rebound. The valve or tap f is employed to open a communication between the air chamber and the cylinder to admit of the return of the fluid to the cylinder, and thus, by acting upon the piston by the force of the compressed air, effect the running up of the carriage again.~~

~~I form the side frames or cheeks of the gun carriage in two parts, through the line z, by which I obtain great facility in forming the internal parts and chambers thereto, and, when fitted, I retain these parts together by screws and nuts, or other suitable means, with a thin layer of soft metal or other suitable material between the surfaces in contact, but this may be varied.~~

~~A workman, from the description given, will readily make such modifications as may be necessary in applying the system to mortar carriages for moderating their recoil, and the sheets or layers of lead or other soft metal between the layers or thicknesses of metal in guns formed of such separate layers or thicknesses, may be either caused to flow in between the parts in a fluid state, or be placed there in sheets.~~

Having thus described the nature of my said Invention, I would have it understood that I do not confine myself to the precise details shown and described, so long as the peculiar character of any part of the improvements be retained.

In witness whereof, I, the said Alexander Theophilus Blakely, have hereunto set my hand and seal, this Sixth day of July, in the year of our Lord One thousand eight hundred and fifty-five.

In witness whereof, I, the said Alexander Theophilus Blakely, have hereunto set my hand and seal, this Fifth day of March, in the year of our Lord One thousand eight hundred and fifty-nine.

Alexander Theophilus Blakely (L. S.).

Witness,
William Brookes,
73, Chancery Lane, London,
Patent Agent.

To the Commissioners of Patents for England.

I hereby grant my fiat, giving leave to the above-named Alexander Theophilus Blakely to file in the Great Seal Patent Office, with the Specification to which the same relates, the above written Disclaimer and Memorandum of Alteration.

FitzRoy Kelly.

Temple, 29 March 1859.

Appendix, No. 59.

PAPERS furnished by Captain *R. A. E. Scott*, R.N., 15 June 1863.

No. 1.—Report of Experimental Practice.—Shoeburyness, 14 May 1860.

Height of axis of gun above plane, 17 feet.

Ordnance - Weight, 59 cwts. 1 qr. 10 lbs.; Length, 9 ft. 6 in.; Diameter of bore, 6·6 in.; Spiral, if rifled, 1 turn in 48 ft.; Grooves, number, 3.

Barometer, 29. 9 m.
Wind, E.S.E. 1.
Direction of wind,
Direction of range, East.

Nature and object of the Experiment:—To ascertain ranges, deflection, &c., with Commander Scott's projectiles, fired from a 32-pounder cast-iron gun, rifled on that officer's principle.

No. of Round.	Charge.	Elevation.	Recoil.	Projectile. Nature.	Projectile. Weight and Mean Weight.	Projectile. Windage in Inches.	Times and Mean Time of Flight.	Range, First Graze.	Mean Range, First Graze.	Deflection. Correction allowed for.	Deflection. Left.	Deflection. Right.	REMARKS.
	Lbs.	*Deg.*	*Ft. in.*		*Mean Lbs.*		*Sec.*	*Yds.*	*Yds.*		*Yds.*	*Yds.*	
1	6 0	5	5 11	Cylindro conical shell, entirely of iron.	40	·1	5·3	1,408	–	Nil.	–	3	Wood bottoms used.
2	–	–	6 0		–	·07	5·8	1,790	–	–	–	1	
3	–	–	6 0		–	·08	6·2	1,909	–	–	–	8	
4	–	–	6 0		–	·06	6·4	1,897	–	–	–	4	
5	7 0	–	6 8		–	·08	6·4	2,054	–	–	–	8⅓	
6	–	–	7 0		–	·07	6·5	2,015	–	–	–	7	
7	–	–	7 0		–	–	6·5	1,993	–	–	–	10	
8	–	–	7 3		–	–	6·5	2,055	–	–	–	8⅓	
9	6 0	–	6 0		36	–	6·3	1,959	–	–	–	13	
10	–	–	6 0		–	–	6·4	1,936	–	–	–	5	
11	–	–	6 0		–	–	6·5	1,974	–	–	–	8	
12	–	–	–	– –	–	–	–	–	–	–	–	–	Without wood bottoms, 15 May.
13	6 0	–	6 4	– –	40	·07	6·2	1,979	–	–	–	5	
14	–	–	6 0	– –	–	–	6·0	1,873	–	–	–	-⅔	Wads back. No bottoms.
15	–	–	6 0	– –	–	·06	6·0	1,894	–	–	–	7	
16	–	–	6 0	– –	–	·07	6·3	1,916	–	–	–	3	
17	7 0	–	6 4	– –	36	–	6·5	2,021	–	–	–	6	
18	–	–	6 9	– –	–	·08	6·3	1,943	–	–	–	3⅓	
19	–	–	6 4	– –	–	–	6·5	2,086	–	–	–	4	

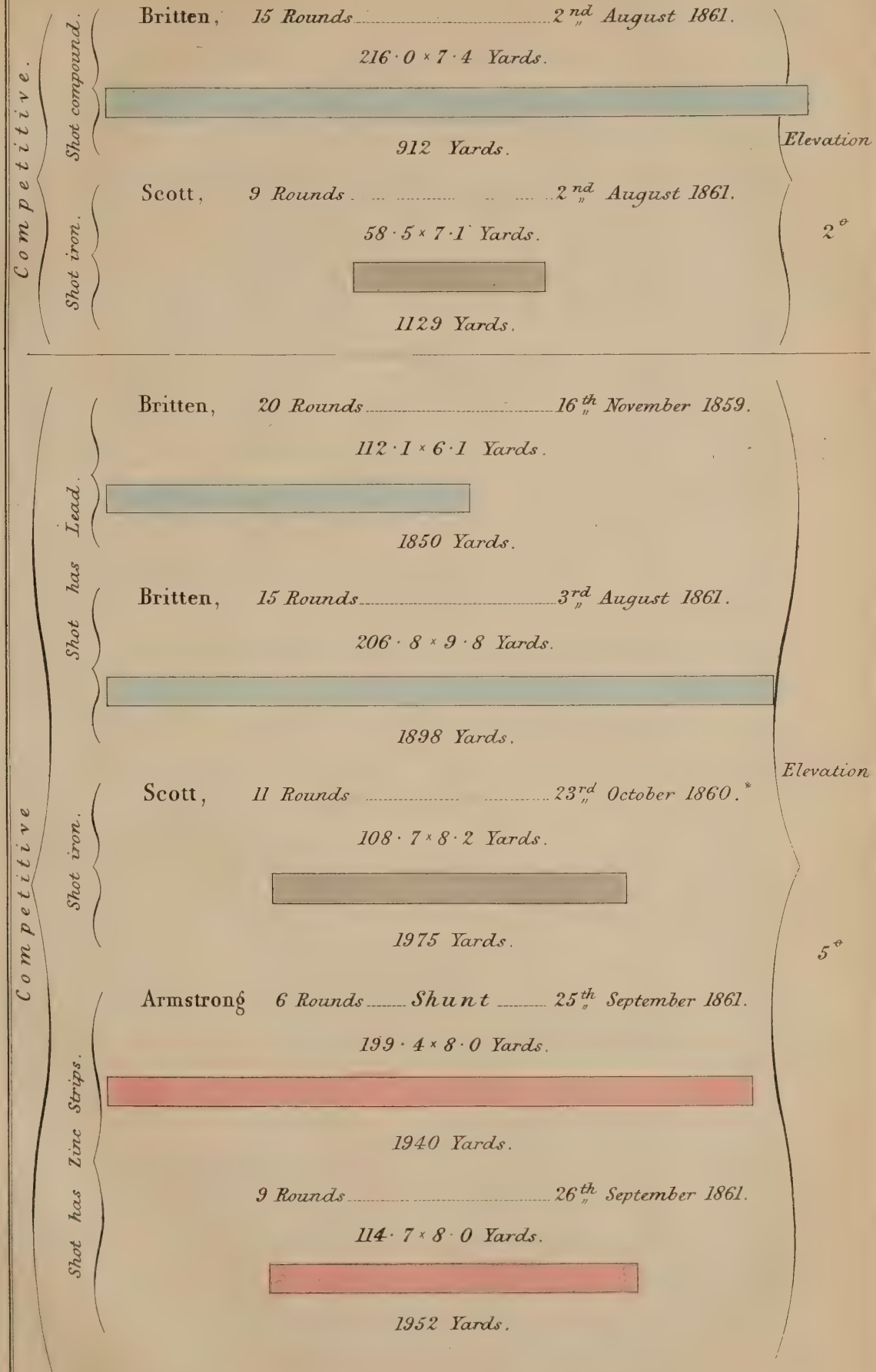
No. 1.—Report of Experimental Practice, &c.—*continued.*

No. of Round.	Charge.	Elevation.	Recoil.	Projectile. Nature.	Projectile. Weight and Mean Weight.	Projectile. Windage in Inches.	Times and Mean Time of Flight.	Range, First Graze.	Mean Range, First Graze.	Deflection. Correction allowed for.	Deflection. Left.	Deflection. Right.	REMARKS.
	Lbs.	*Deg.*	*Ft. in.*		*Mean. Lbs.*		*Sec.*	*Yds.*	*Yds.*		*Yds.*	*Yds.*	
20	–	–	8 0	- -	46	·06	6·4	2,022	–	Nil.	–	$9\frac{1}{3}$	Neither wads nor bottoms.
21	–	–	8 0	- -	–	·06	6·4	2,084	–	–	–	5	
22	6 0	–	4 9	32-pounder service shot.	32	·425	6·0	1,667	–	–	14	–	
23	–	–	4 9		–	·41	5·9	1,652	–	–	$4\frac{1}{3}$	–	
24	–	–	4 4		–	·425	5·6	1,580	–	–	–	9	
25	–	–	4 6		–	·405	5·9	1,639	–	–	$8\frac{1}{3}$	–	
26	–	–	4 3		–	·41	Not observed.	1,664	–	–	4	–	Wind changed.
27	7 0	–	5 3		–	·415	6·2	1,746	–	–	1	–	
28	–	–	5 3		–	–	6·4	1,805	–	–	$5\frac{1}{3}$	–	
29	–	–	5 4		–	·425	6·1	1,769	–	–	5	–	
30	–	–	5 4		–	·41	6·1	1,772	–	–	18	–	
31	–	–	5 4		–	–	6·1	1,798	–	–	8	–	
32	7 8	10 0	8 1	Cylindro conical shell entirely of iron.	47	·09	11·9	3,419	–	–	–	4	Wood bottom, no wad.
33	–	–	7 9		–	·07	11·5	3,136	–	–	–	5	Neither bottoms nor wads.
34	–	–	8 0		–	·07	11·3	2,826	–	–	12	–	

* All the wads were high. After firing some rounds, the shells had to be forced home with a heavy rammer.

(signed) *J. W. Mitchell,* Colonel, Royal Artillery,
Commandant and Superintendent.

DIAGRAMS COPIED FROM REPORT, ORDNANCE SELECT COMMITTEE.



*Fired previously to Competition, when Gun burst at the 10th round, 310 in all.

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Appendix, No. 60.

LETTER from the Elswick Ordnance Company to the Right Hon. *W. Monsell*, M.P.

App. No. 60.

Elswick, Newcastle-upon-Tyne,
Sir, 16th June 1863.

We understand that the Assistant Accountant General of the War Office has lately laid before your Committee a statement purporting to show the comparative cost of guns made at Woolwich and Elswick, and exhibiting the saving which would have been effected had the whole of the guns been made at Woolwich. The re-opening of this question on the part of Mr. Whiffin obliges us to address the Committee again upon the subject.

Had the question of comparative cost been allowed to rest upon the evidence taken last Session, we should have been content, but since Mr. Whiffin puts forward his contested figures afresh, and as though they were incontestible, we feel obliged to re-assert that the principles upon which the indirect charges of the Royal Gun Factory have been levied upon the work executed, are such as to relieve the guns from their due proportion of those charges; and also to point out that the apparent economy of manufacture in the Royal Gun Factory, is alone to be found in those articles which were made in competition with Elswick.

The Parliamentary Return of the Army Manufacturing Establishments, No. 176, contains a list of the various subsidiary articles and special services which, in the year 1861-2, absorbed about one-half of the entire expenditure of the Royal Gun Factory. The return also shows the rates charged upon the various articles for general expenses, but not for depreciation and interest which are yet to be added. We propose to show by examples from this list, not only that the charges imposed and to be imposed upon the articles are excessive; but that these charges are enhanced by the successive cost of the articles themselves. As there are no contract prices, by which to test the reasonableness of the costs which figure in this list, we shall, in the first place, confine our criticisms to those instances in which we happen to have data for comparison, although in point of amount those instances are of less importance than others to which we shall afterwards refer.

At page 26 of this Parliamentary Return, a charge will be found of 421 *l.* 8 *s.* 5½ *d.* for making a small model of a 100-pounder gun for the Ordnance Select Committee. Now, according to the estimate adopted by Mr. Whiffin, it would appear that the cost of the actual full sized gun is only 387 *l.*, so that the cost of the model is represented to be about 11 per cent. greater than that of the actual gun. It will be perceived that this model is charged with no less than 115 *l.* 16 *s.* 6¼ *d.*, as its share of the general expenses of the establishment, whereas the sum put upon the gun itself in the Accountant's statement is only 45 *l.* Thus, the model which required neither plant nor capital to speak of, is saddled with two and a half times the charge put upon the gun which employed both plant and capital to a large amount, and chiefly gave rise to indirect expenditure.

The same excessive cost and excessive charge for general expenses is exhibited at page 27, in the case of models of Ballistic pendulums, also made for the Ordnance Select Committee. These models are charged at the enormous price of 536 *l.* 15 *s.* 6¾ *d.*, and are made to carry 147 *l.* 19 *s.* 8¼ *d.* as their share of the general expenses. Now, it happens that the Ballistic pendulums which these models represent, and which are very large machines, were made at the Elswick Engine Works, at the price of 800 *l.*, and the Elswick Ordnance Company actually offered to make these very models for 100 *l.*; but they were given to the Royal Gun Factory upon the assurance that the cost would not exceed our offer. As we had furnished the drawings for these models, we felt that we had some reason to complain of the course which was taken, but that is not a matter belonging to our present criticism.

At page 29, the two following items occur:—

"Making chain pulley for 6-ton hydraulic crane - - - 30 *l.* 5 *s.* 0½ *d.*

"Making a solid web pulley, in lieu of an open arm one, for 10-ton crane 50 *l.* 10 *s.* 8½ *d.*"

Thus two common cast-iron crane pulleys are shown to have cost upwards of 80 *l.* We may perhaps assume the fixing to have been included, but we can undertake to say that the work would have been executed for less than half that sum in the Elswick Engine Works, where the cranes were made.

The following are charges for rifling guns:—

	£.	s.	d.
Rifling a 70-pounder muzzle loading gun from Mersey Iron Company, on the shunting plan - - - - -	114	2	-¾
Rifling two 32-pounder guns on the French plan - - - - - -	45	9	8½
Rifling one 100-pounder unstrengthened gun with the ordinary form of groove, but with a pitch of one turn in 50 calibres - - - - - -	25	14	11
Rifling one 32-pounder gun on shunt plan - - - - - - -	57	14	10

This gives an average cost of 48 *l.* 12 *s.* 3 *d.* for rifling these five guns. As the shunting plan is charged the highest, we may assume it to have justified the highest price, but our price charged to the Government for rifling guns of the 32-pounder calibre upon this plan, was only 6 *l.* 10 *s.* We may anticipate the argument, that so small a number of guns required special preparations, but we would point out that ample preparations

App. No. 60.

for rifling guns on the "shunt and other experimental plans," are stated, at page 35, to have been made at a cost of 2,883 *l.* 0 *s.* 10½ *d.*

At page 34, there occurs a charge of 23 *l.* 15 *s.* 1½ *d.*, for making one 100-pounder, and two 40-pounder wooden vent-pieces. According to prices which the Royal Gun Factory put forward, in competition with us, these same three vent-pieces might have been supplied of iron, faced and bushed with copper, and fit for actual use, for 17 *l.* 6 *s.* 1 *d.*, so that wooden vent-pieces made without competition have cost more than iron and copper vent-pieces made under the influence of rivalry.

At page 22, fuze-keys for Armstrong guns are charged at 1,086 *l.* 17 *s.* 11½ *d.* The pattern of this fuze-key was designed by us, and to cover the small expenses of the design, the first two dozen were charged at prices varying from 10 *s.* to 3 *s.* Afterwards, anticipating further orders, we obtained from Sheffield 200 of them at 2 *s.* 6 *d.* each, but the orders never came, and the 200 remain in our hands to this day. The price at which they can be obtained by contract is thus definitely ascertained to be 2 *s.* 6 *d.*, and the sum expended in making them in the Royal Gun Factory, would therefore have produced 8,695. What number has been made does not appear, but it is inconceivable that any such number could have been required.

At page 21, a stopper for a 70-pounder wedge gun, for the Elswick Ordnance Company, is charged at 31 *l.* 14 *s.* 7 *d.* The price at which these stoppers will be charged by us to the Government, including all charges and profit, is 6 *l.* 12 *s.*

In the foregoing cases we have been enabled to test the fairness of the charges by reference to some known data. The number of cases which can be so tested is naturally very limited, but we have no hesitation in saying, that nearly the whole list bears the impress of excessive cost, and of excessive rating to general charges. We will produce in illustration, five items of mere subsidiary work, which, although employing an insignificant portion of the plant and capital of the factory, are nevertheless charged with nearly as large a share of the general expenses, as is put upon the whole of the guns themselves, which constitute the staple manufacture of the place. These items are, sighting and browning of guns, making saddles and hammers for 110-pounders, and supplying facing implements and tools to accompany guns. Their aggregate cost is 108,957 *l.*, and they are charged with the enormous sum of 20,957 *l.* 1 *s.* 3½ *d.*, as their share of the general expenses, which is at the rate of nearly 25 per cent. upon their cost. On the other hand, the rate put upon the guns amounts to only 13¾ per cent. upon their cost. The item for sighting and browning alone, amounts to 62,950 *l.*, and carries nearly 13,000 *l.* of the general expenses; and we would further point out that the sum of 62,950 *l.* said to have been expended under this head, would have been adequate to produce 1,124 9-pounder Armstrong guns, at the price at which they are assumed to be made in the Royal Gun Factory.

At page 23, there is a charge of 1,786 *l.* 4 *s.* 3 *d.* for knives with springs for cleaning ordnance. This is one of the few instances in which the number of the articles is given. It is stated to amount to 370, which makes the cost amount to the extraordinary sum of 4 *l.* 16 *s.* a-piece.

At page 23, implements for taking impressions in gutta percha are set down at 686 *l.* 19 *s.* 5¾ *d.* How many were made is not revealed; and we can only say that the implement used at Elswick for this purpose, and which is perfectly effective, can be supplied at 30 *s.*

At page 28, making iron tongs for lifting 12-pounder shells for Ordnance Select Committee, is charged at 505 *l.* 13 *s.* 4½ *d.* The material used in the manufacture of these tongs is stated to have been of the value of only 24 *l.* 12 *s.* 7 *d.*, so that in the manufacture of a common article of hardware the cost of the article is stated at 20 times the value of the material used.

At page 33, we have 41 wooden saddle trees for bearing the guns, charged at 560 *l.* 0 *s.* 5 *d.*, being at the rate of 13 *l.* 13 *s.* for each. We are ignorant of the pattern adopted by the Royal Gun Factory, but the articles which we use for the same purpose, and which are neat, efficient, and durable, cost only 13 *s.* for each 110-pounder.

At pages 33, 34, and 35, 33 mere hooks for pulling out tin cups from the guns, are charged at an average rate of 2 *l.* 10 *s.* 5 *d.* each, a price which is altogether incomprehensible.

There are many other items which excite our wonder at their amount, although the numbers made are not stated. Unless, however, the numbers be excessive, the cost must be extravagant; we adduce the following examples:—At page 22, the percussion hammers for 110-pounder Armstrong guns are put down at 7,158 *l.* 10 *s.* 3¾ *d.* At page 24, spring searchers are charged 1,848 *l.* 4 *s.* 3½ *d.* At the same page, springs for holding knives are set down at 839 *l.* 17 *s.* 11 *d.*

The rates levied upon the net cost of these various articles for general expenses is, in many cases, three times as much as is put upon the guns.

In the case of artificers sent out of the factory to do work at a distance, as at Portsmouth, or Shoeburyness, it will be found that their wages and travelling expenses are charged with about 40 per cent. in aid of the fund which has to meet the general expenses of the establishment. Such simple operations as packing guns and examining stores, are also charged with between 30 and 40 per cent. towards general expenses. For the former, an item of 1,291 *l.* 19 *s.* 3¾ *d.* occurs at page 22; and for the latter, a charge of 386 *l.* 9 *s.* 8¾ *d.* will be found at page 28. It is clear that no tradesman could carry on his business if he made such charges as these, even inclusive of his profit.

We not only object to the amounts charged for labour in this list, and the rates levied for general expenses, but we object to some items being treated as special services, which ought to have been embodied in the general expenses of the establishment.

Thus, at page 35, a charge is made of 316 *l.* 16 *s.* 2½ *d.* for taking the "remain" or annual valuation of stock. The expense of stock-taking is simply an incident to carrying on the business, and obviously, therefore, ought to have been added to the general expenses to be levied on the produce of the factory. The cost, however, of taking the stock is charged as an extra, and instead of being added to general expenses, it is actually assessed with a rate of upwards of 40 per cent. *in reduction* of general expenses.

Another item of the same nature, but involving a more serious amount, occurs at page 34. It consists of a charge of 2,261 *l.* 5 *s.* 9½ *d.*, "for drawings, models, and specimens of war stores for the International Exhibition of 1862." Here again

again is an expense which is purely an incident to carrying on the business. If there had been no Royal Gun Factory, no such expense would have been incurred. Our firm exhibited almost as largely as the Royal Gun Factory, and were only allowed to do so under the name of the Secretary of State for War, and yet not one penny of the expense was paid to us. We, therefore, must add the cost of exhibiting to our general expenses; but the Royal Gun Factory has the convenient alternative of treating the transaction as a special service, by which the general expenses of the establishment are saved from any addition, and are, in fact, reduced by a levy of 448 *l.* 13 *s.* 8½ *d.*, imposed under the head of proportionate share of other expenses.

The concluding item of this miscellaneous list is perhaps as instructive as any. It is a charge of 955 *l.* 19 *s.* 7¼ *d.*, for "pay and instruction of military artificers." These artificers acquire their instruction by working in the factory. It may be that their services are not equal to their wages; but, at all events, they execute work, and, since their full wages are charged as extras, the factory gets this work for nothing. This advantage might perhaps be fairly allowed as a set-off against the trouble of instruction; but it will be seen that the actual wages paid only amount to 687 *l.* 17 *s.* 4½ *d.*, the total sum charged being made up by an addition of 277 *l.* 2 *s.* 2¾ *d.*, as a subscription to the general expenses of the factory.

No opportunity is lost of levying a tax in aid of general expenses. We have lately had a bill sent in against us for repairs executed in the Royal Gun Factory to a 110-pounder gun injured at proof. The repairs cost 52 *l.* 12 *s.* 1 *d.*, and the "departmental expenses" are put down at 31 *l.* 8 *s.* 2 *d.*, being nearly 60 per cent. on the money expended. The occasion, however, for this unusually heavy assessment was not opportune; for the repairs were abortive, and the gun was spoiled.

But although the extra articles and services comprised in the Parliamentary List are already so loaded with general expenses as to be out of the pale of competition, it appears they are not yet saddled with the whole amount to be put upon them. It is now conceded that the guns should be charged with interest on capital and depreciation on plant; but it seems to be decided that the miscellaneous articles are to carry a share of these capital charges nearly, if not fully, proportionate to the share of general expenses already laid upon them.

We must protest, however, against these heavy charges being imposed upon the miscellaneous services of the Royal Gun Factory, thereby making the cost of the guns, which alone had been subject to competition, appear in favourable contrast with our prices. The Royal Gun Factory is essentially a manufactory of rifled ordnance, and any one who visited the establishment in the year of which we are speaking might have seen that its strength was exerted upon the guns, and not upon the miscellaneous articles. It was the guns that occupied all the important machines, and absorbed nearly all the capital. It was the guns that caused depreciation, and required constant accessions of new machinery. It was the guns that chiefly involved the indirect labour and material which constitute the largest items of general expenses. In fact, the subordinate services might have been swept away altogether without effecting a large diminution of the indirect charges; and it is plain, therefore, that the guns, instead of being debited with a less proportion of indirect charges than the miscellaneous articles, ought to have been debited with a much larger share. It is no justification to say that these results flow from the rule which has been adopted of treating wages as the sole basis upon which to assess the general charges. The results only show how well founded our arguments were against that rule. The fact is, the miscellaneous services are, for the most part, so totally distinct from gun making, that the two classes of work ought not to be treated on the same footing. Each should bear its charges in proportion to the expenses it involves. No contractor for such common articles as "tin lamps, iron pots, punches, knives, prickers, scrapers, and tongs," which make up a considerable portion of the list, or even for the staining of guns, which appears to have cost such an enormous sum, would have deemed it necessary to add more than 10 per cent. on the net cost for the *whole* of his trade expenses, and yet an average of 26 per cent. for general expenses *alone*, without capital charges, is imposed upon these very things in the Royal Gun Factory, while the guns which chiefly require the capital and mainly cause the expenses are let off about half that rate.

In the evidence we gave last year, we pointed out that in making comparison between our prices and those of the Royal Gun Factory, it was necessary to take into account the date at which the guns were made, the pattern existing at the time, and the magnitude of the orders for each kind of gun.

We also showed that the prices put forward as our prices for the 110-pounder gun, included other things supplied to the Government. All this will be found at page 91 of last year's evidence; but Mr. Whiffin, whose signature authenticates the paper which has called forth this letter, ignores everything that we have said on the subject. More than that, he puts down the cost of the 100-pounder gun, in the Royal Gun Factory, at 387 *l.* 10 *s.* 9 *d.*, which sum he takes from a paper put in by Mr. Anderson, appearing at page 236 of last year's Appendix. Common fairness would seem to have demanded that some notice should have been taken of the fact that the same paper contains an alternative estimate equally entitled to acceptance, in which the cost is stated to be 424 *l.* 13 *s.* 1 *d.* For our part, we can assent to neither estimate, and we feel that we have a right to repudiate any comparison between the cost of the guns at Woolwich and at Elswick, until an account is produced in which the miscellaneous articles shall be charged at prices which will bear as favourable a comparison with trade prices in general, as the prices set upon the guns shall bear to our prices.

We have not thought it necessary to re-open the question of the comparative costs of the ammunition, being content to rest our case upon our previous evidence.

We trust the Committee will permit this letter to appear in the Appendix to this year's Evidence, in conjunction with the Paper in which the comparison between our prices and those at Woolwich is renewed.

We have, &c.
The Elswick Ordnance Company,
(signed) *John G. W. Rendel.*

The Right Hon. W. Monsell, M.P.,
Ordnance Committee, House of
Commons.

Appendix No. 60*a*.

LETTER from the ELSWICK ORDNANCE COMPANY to the Right Honourable *W. Monsell*, M. P.

Sir,

Newcastle-on-Tyne, 4 July 1863.

WE have the honour to enclose, as addenda to our letter to you of the 16th ultimo, Tabular Statement, showing what we consider to be a more correct account of the indirect charges in the Royal Gun Factory, and a proper apportionment of those charges on the work done, together with an Estimate of the real cost of the work deduced therefrom, and from figures given in evidence before your Committee.

We have, &c.
For the Elswick Ordnance Company,
John G. W. Rendel.

The Right Honourable W. Monsell, M. P.,
&c. &c. &c.,
Ordnance Committee, House of Commons.

(A.)

STATEMENT showing Corrected Amount of GENERAL EXPENSES and CAPITAL CHARGES in the Royal Gun Factories, for the Year 1861-62.

REFERENCES:		£.	£.
	1. GENERAL EXPENSES:		
Ordnance Report, p. 183 - -	Mr. Whiffin's Return - - - - - - - -	63,300	
Army (Manufacturing Establishments) Return, p. 35.	"Taking the remain" - - - - - - - -	316	
Ditto - ditto, p. 34 - -	Making drawings, &c. for International Exhibition, 1862	2,293	
Ordnance Report, p. 122 - -	Parochial rates - - -		
Ditto - ditto p. 82 - -	Property tax - - - - } say - - - -	1,000	
Ditto - ditto Q. 1852 - -	Pensions and medical staff, &c.		66,909
	2. CAPITAL CHARGES:		
	INTEREST: £.		
Ordnance Report, p. 239 - -	Buildings and machinery, 3½ % on 224,433 - -	7,855	
Ditto - ditto p. 90 - -	Wharves, roads, &c. „ on 45,600 - -	1,596	
Ditto - ditto p. 83, Q. 1852	Land „ on, say, 10,000 - -	350	
Army (Manufacturing Establishments) Return, p. 19.	Stock and stores, 3½ per cent. on— £. April 1861 - 180,907 „ 1862 - 117,420		
	2)298,327 = 149,163 - - -	5,220	
	Balance at Bank - - - - - - - - -	- -	15,021
	DEPRECIATION:		
Army (Manufacturing Establishments) Return, p. 36.	Building, at 5 per cent. on - 67,369 - - -	3,368	
	Wharves, roads, &c, at 5 per cent. on 45,600 - - -	2,280	
	Machinery, at 10 per cent. on - 157,064 - - -	15,706	
			21,354
	TOTAL of General Expenses and Capital Charges - £.		103,284

(B.)

STATEMENT showing Proportions of GENERAL EXPENSES and CAPITAL CHARGES (as per Statement A.) to be carried by Guns and Miscellaneous Services respectively, for the Year 1861–62, if levied according to Mr. Whiffin's System of charging General Expenses on Direct Labour and Capital Charges on the Entire Cost. *Vide* Appendix 44 (1863), and Ordnance Report, p. 236.

REFERENCES:	GUNS:	£.	£.	£.
Ordnance Report, p. 236 - -	Labour, after deducting rateably for eighty 110-pounders, made 1860–61.	65,106		
	Material - - - - - - - -	128,717		
			193,823	
	General Expenses, at 41·95 % on direct labour	27,312		
	Capital Charges, at 8·54% on entire cost -	18,885		
			46,197	
	N.B.—General Expenses and Capital Charges amount, together, to 23·8 per cent. upon cost of labour and material.			240,020
	MISCELLANEOUS SERVICES:			
Army (Manufacturing Establishments) Return, p. 35.	Labour - - - - - - - -	94,367		
	Material - - - - - - - -	70,673		
			165,040	
	General Expenses, at 41·95% on direct labour	39,587		
	Capital Charges, at 8·54% on entire cost -	17,475		
			57,062	
	N.B.—General Expenses and Capital Charges amount, together, to 34·57 per cent. upon cost of labour and material.			222,102

(C.)

STATEMENT showing Proportions of GENERAL EXPENSES and CAPITAL CHARGES (as per Statement A.) to be carried by Guns and Miscellaneous Services respectively, for the Year 1861–62, if levied, as contended for by the Elswick Ordnance Company—on Miscellaneous Services, at 15 per Cent.* on the Cost of Labour and Material, and on Guns at 40·52 per Cent. on the Cost of Labour and Material.

REFERENCES:	GUNS	£.	£.	£.
Ordnance Report, p. 236 - -	Labour, after deducting rateably for eighty 110-pounders, made 1860–61.	65,106		
	Material - - - - - - - -	128,717		
			193,823	
	General Expenses and Capital Charges, at 40·52 per cent. on cost of labour and material. - -		78,537	272,360
	MISCELLANEOUS SERVICES:			
Army (Manufacturing Establishments) Return, p. 35.	Labour - - - - - - - -	94,367		
	Material - - - - - - - -	70,673		
			165,040	
	General Expenses and Capital Charges, at 15 per cent. on cost of labour and material. - -		24,756	189,796

* It is contended that this per-centage is as large as a contractor would find it necessary to impose on such articles.

(D.)

STATEMENT showing COST of each 110-Pounder made in the Royal Gun Factories in 1860-61, 1861-62, if General Expenses and Capital Charges be levied, as shown in Statement (C.)

REFERENCES:	110-POUNDER:	£. s. d.	£. s. d.	£. s. d.
Ordnance Report, p. 179 -	Labour - - - - - - - -	102 9 10		
	Material - - - - - - - -	215 11 –		
			318 – 10	
	General Expenses and Capital Charges, at 40·52 % on cost of labour and material -	- - -	128 17 –	
				446 17 10

(E.)

STATEMENT showing APPROXIMATE COST of each of the First 208 110-Pounders made in the Royal Gun Factories.

REFERENCES:		£. s. d.	£. s. d.	£. s. d.
Ordnance Report, p. 179 -	Labour—average of 1860–61, 1861–62 -	102 9 10		
Ordnance Report, Q. 1366–1574.	Extra labour at commencement of manufacture (150 *l.*, less 102 *l.* 9 *s.* 10 *d.*) - - -	47 10 2		
Ordnance Report, p. 185 -	Material - - - - - - - -	218 18 9		
			368 18 9	
	General Expenses and Capital Charges, at 40·52% on cost of labour and material, as per Statement (C.) - - - - - -	- - -	149 10 –	
	Cost of preparation in special tools, as ascertained at the Elswick Ordnance Works at same period - - - - - - -	- - -	40 2 –	
Ordnance Report, p. 91, Q. 1963.	Saving by the use of solid forged barrels,* instead of coiled barrels, and by non-user of existing material for unstrengthened pattern 110 pounder - - - - - - -	- - -	44 – –	
				602 10 9

* The whole of the first 208 guns made at Woolwich had barrels formed of solid forgings bored out: they will require to be rebarrelled with coiled tubes, to make them as good as the Elswick guns.

The Elswick Ordnance Company completed no 110-pounder of the unstrengthened pattern, and used up in the manufacture of the strengthened pattern all the available materials of the preceding pattern, without making any extra charge. Their price for the first 208 guns, with coiled barrels, was 671 *l.*, and not 700 *l.* as stated. (*See* Ordnance Report, p. 91, Q. 1963).

Appendix, No. 61.

ACCIDENTS reported to have happened to ARMSTRONG GUNS belonging to SHIPS in the *Mediterranean* whilst Rear-Admiral *Dacres* was on that Station. App. No. 61.

Ship.	Description of Gun.	Date of Accident.	Description of Accident.
		1862:	
Queen - -	100-pounder -	22 January	- - On the first time of firing a flaw of three-fourths of an inch long, 10 inches from the muzzle, and one one-half of an inch long 11 inches from the muzzle. These defects had been filled up with tallow and white lead.
Queen - -	40-pounder -	4 June -	- - Difficulty being found in forcing a shell up to its place in the chamber, the cartridge was reduced, and the gun fired. On examination, a piece of one of the grooves, an inch long, was found to be started.
Queen - -	40-pounder, same as above.	15 Sept. -	- - After firing five shot and two shell, a piece of the groove was found turned back.
Doris - -	2 100-pounder 2 40-pounder.	- June -	- - General defects reported by the military armourer at Malta to have been caused by excessive firing. A return of the number of rounds fired is given, from which it would not appear that the defects could have been caused by excessive firing. The gun (a 110-pounder) which was least used, was the most defective.
Alacrity -	110-pounder -	- July -	- - General defects reported by the military armourer to have been caused by excessive firing. The whole number of rounds fired from this gun was 25. The largest number of shot and shell fired at one time was eight.

Rear-Admiral Dacres begs leave to forward the above for the information of the Select Committee on Ordnance, House of Commons, as he was unable to obtain access to the necessary documents before. Since the 24th inst., three accidents with Armstrong guns (110-pounders) have occurred in the Channel Squadron.

1. In "Edgar," neck of vent-piece cracked nearly through from after to foremost side, after three rounds firing with shot; gun properly screwed up and loaded.

2. In "Defence," upper part of vent-piece blown off and up, firing blank cartridge; gun imperfectly screwed up; two men seriously and one man slightly hurt.

3. In "Black Prince," some accident from a jam not yet reported in detail.

By order of Rear Admiral S. C. Dacres,

George Love, Secretary.

Her Majesty's Ship, "Edgar," at Portland,
26 June 1863.

Appendix, No. 62.

RETURN of STRENGTHENED CAST-IRON GUNS which have been Tested in Experiments under the Ordnance Select Committee since the Year 1858.

Date Submitted.	DESCRIPTION OF GUN.	Calibre.	Weight.	Date of last Test.	Charge of Powder.	Weight of the Single Shot.	Number of Rounds Fired with Cylinders in Weight equal to										REMARKS.
							1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	
		Inches.	*Cwt. qrs. lbs.*		*Lbs.*	*Lbs.*											
1858	10-inch cast-iron smooth-bored gun, strengthened with wrought-iron rings in the Royal Gun Factories, No. 5,071	10	88 0 0	28 Nov. 1859	20	131½	10	10	10	9	–	–	–	–	–	–	Burst 39th round.
1857	68-pounder cast-iron smooth-bored gun, strengthened with wrought-iron rings in the Royal Gun Factories.	8·12	96 2 0	9 Jan. 1860	16	68	10	10	10	10	10	1	–	–	–	–	Burst 51st round.
1860	68-pounder cast-iron smooth-bored block, proved in a 32-pounder calibre, and afterwards turned, slightly tapering from trunnion to breech, and hooped on a plan proposed by Col. St. George, C.B. and bored up to a 68-pounder calibre.	8·12	97 3 14	8 Nov. 1860	16	68	10	10	10	10	10	10	7	–	–	–	Burst 67th round.
1860	Another similar gun - - - - -	8·12	97 3 8	30 Nov. 1860	16	68	10	10	10	10	10	10	8	–	–	–	Burst 68th round.
1859	68-pounder cast-iron smooth-bored gun, strengthened by Mr. Lancaster.	8·12	120 3 0	28 Feb. 1861	16	68	10	10	10	10	10	10	1	–	–	–	Burst 61st round.
1860	Smooth-bore block of cast-iron, cast specially for hooping, strengthened with wrought-iron hoops, as proposed by Sir W. Armstrong.	7·0	95 2 0	2 May 1860	16	45	10	10	10	6	–	–	–	–	–	–	Burst 36th round.
1860	Smooth-bore block of cast iron, cast specially for hooping, as above.	7·5	89 2 0	4 May 1860	16	55·75	10	10	2	–	–	–	–	–	–	–	Burst 22d round.
1860	68-pounder cast-iron block, rifled on the shunt principle, strengthened in the Royal Gun Factories with wrought-iron hoops.	6·5	95 0 0	16 Feb. 1860	13	90	4	–	–	–	–	–	–	–	–	–	Burst at 4th round.
1860	Smooth-bore block of cast-iron, cast specially for hooping, strengthened with wrought-iron hoops in the Royal Gun Factories.	6·5	97 3 0	17 April 1860	16	35	10	10	10	6	–	–	–	–	–	–	Burst 36th round.
1859	68-pounder cast-iron block, rifled on the shunt principle, and strengthened in the Royal Gun Factories with wrought-iron rings.	6·5	95 0 0	18 April 1860	18	89	10	2	–	–	–	–	–	–	–	–	Burst 12th round.

1860	68-pounder cast-iron smooth-bored gun, with internal tube of wrought-iron.	6·5	101	0	0	6 Nov. 18 60	16	68	10	10	10	10	10	10	10	1	–	–	Burst 71st round.
1860	Smooth-bore block of cast-iron, cast specially for hooping, strengthened with envelope of gun metal, on a plan proposed by Captain Caffin, Royal Navy, Director of Stores.	6·5	120	3	0	20 Nov. 1860	16	35	10	10	2	–	–	–	–	–	–	–	Burst 22d round.
1860	Another similar gun - - - -	6·5	120	3	0	28 Dec. 1860	16	35	10	10	10	1	–	–	–	–	–	–	Burst 31st round.
1860	70-pounder cylinder, strengthened by Captain Blakely, and rifled, to fire Mr. B. Britten's projectiles - - -	6·5	78	2	14	24 Mar. 1862	7·5	90	10	10*	10	4	–	–	–	–	–	–	50 with 8 lbs. charge, and shot 67½ lbs.
							8·0	67½	50	–	–	–	–	–	–	–	–	–	Gun burst at the 84th round.
1860	32-pounder block, strengthened by Captain Blakely, and rifled to fire Mr. B. Britten's projectiles - - -	6·5	68	1	18	16 July 1862	5·0	48	10	10†	10	10	10	10	10	10	3	–	50 with 8 lbs. charge, shot 67½ lbs.
							8·0	67½	50	–	–	–	–	–	–	–	–	–	Gun burst at 133d round.
1860	32-pounder cast-iron block, proved in a smooth-bore 18-pounder calibre, and afterwards turned, slightly tapering from trunnions to breech, and hooped on a plan proposed by Colonel St. George, C.B., and then bored up to a 32-pounder calibre.	6·375	60	0	2	1 No. 18 60	10	32	10	10	10	10	10	10	7	–	–	–	Burst 67th round.
1860	Another similar gun - - - -	6·375	60	0	0	8 Dec. 1860	10	32	10	10	10	10	10	9	–	–	–	–	Burst 59th round.
1860	32-pounder cast-iron smooth-bored gun, strengthened with wrought-iron jacket and hoops by Mr. Lancaster - -	6·375	76	3	0	9 Oct. 1861	10	32	10	10	10	10	10	10	10	10	1	–	Burst 81st round.
1859	Smooth-bore block of cast-iron (70-pounder), cast specially for hooping, strengthened with wrought-iron hoops by Mr. Lancaster.	6·375	104	3	0	15 Oct. 1861	16	68	10	10	10	5	–	–	–	–	–	–	Burst 35th round.
1860	32-pounder smooth-bored cast-iron gun, with internal lining of wrought-iron.	5·26	62	0	0	13 Aug. 1862	10	32	10	10	10	10	10	10	10	4	–	–	At 74th round, inner tube moved forward, cutting off vent, and stopping firing; lining cracked, and deep flaws and fissures in bore.

* In this experiment the cylinders were increased by the weight of half a shot only, every 10 rounds, instead of by the weight of one shot, as in other cases.

† Cylinders increased by half-shots, weight as above.

War Office, 27 June 1863.

Alex. T. Tulloh, Major General,
Director of Ordnance.

Appendix, No. 63.

LETTER read by the Chairman, 2 July 1863.

App. No. 63.

My dear Sir, 30 June 1863.

I HAVE received your letter, in which you ask me to give you information on certain points in a more distinct form than that in which they appear in the correspondence you have put in evidence before the Ordnance Committee.

In reply, I beg to state (what I was prepared to state in evidence, had I been examined):—

That when I was associated with Mr. Whitworth, in 1854, for the purpose of informing him upon matters connected with gunnery, &c., I did, at one of my first interviews with Mr. Whitworth,—I think at my first interview, on the 11th March 1854,—communicate to Mr. Whitworth the fact that I had then made a polygonal rifle for Mr. Brunel.

That I discussed the idea of this rifle fully with Mr. Whitworth.

That Mr. Whitworth did not inform me that he had himself conceived the idea, or made a model of a polygonal rifle.

Very truly, &c.

(signed) *Westley Richards.*

Isambard Brunel, Esq.

Appendix, No. 64.

COPY of the REPORT of the ORDNANCE SELECT COMMITTEE, respecting an offer made by Captain *Blakely* to make a 12-inch-bore GUN, weighing 10 tons; and of the CORRESPONDENCE between him and the War Office on the subject.

App. No. 64.

Army and Navy Club,
Sir, 20 December 1860.

SOME years ago I had the honour of suggesting to Her Majesty's Government the construction of cannon much larger than any in the service, (for special purposes, such as the bombardment of maritime fortresses from the sea, and the destruction of stone-built batteries).

I explained that the difficulty of construction could be overcome by building up the cannon of concentric tubes, the outer ones compressing the inner with a strain to be so adjusted, that the whole thickness of the mass of metal should be used in resisting the explosion of the gunpowder. I gave calculations for ascertaining the proper degree of relative compression and extension of the parts of cannon so constructed.

The Ordnance Select Committee recommended that very large cannon should not be made at all, and expressed an opinion that cannon constructed on my plan "could never be considered safe."

Since that time, Sir William Armstrong has built up cannon, but not on my plan, as he stated to the Institution of Civil Engineers in March last, that he did not regulate the compression of the inside by the outside. Lord de Grey also informed me in an official letter by your orders, that Sir William does not use my plan.

My object in writing to you, Sir, is to ask the favour of being permitted to bring the same proposition personally before the present Ordnance Select Committee.

My reasons for venturing to request that the questions may be reconsidered, are,—

1stly. The recent construction of large iron-plated ships, which I can make cannon strong enough to pierce with certainty.

2dly. The probability that I may be able to induce the Committee to alter its verdict on my plan of building up cannon, by informing it of the experiments I have made since I first made the discovery, and by pointing out why Sir William Armstrong's attempt to build cannon (without adjusting the initial tension of the outer parts) has failed.

I am in great hopes of persuading the present Committee of the correctness of my views, as I have already succeeded in changing the opinion of several individual Members of the former Committee, and in obtaining the sanction of many scientific bodies to my views. I may mention, that they are accepted as correct by the French Government, and are being acted on in France.

I have, &c.
(signed) *T. A. Blakely.*

The Right Hon.
The Secretary of State,
War Office.

(80—B—258.)

War Office,
Sir, 31 December 1860.

I AM directed by Mr. Sidney Herbert to acknowledge the receipt of your letter of the 20th instant, having reference to some plans proposed by you for building up guns, and to inform you in reply, that any proposition you may desire to make will be duly considered, if submitted in accordance with the rules of this department, in respect to inventions, a copy of which is herewith enclosed.

I am, &c.
(signed) *B. Hawes.*

Captain Blakely,
Army and Navy Club.

Army and Navy Club,
Sir, London, 22 January 1861.

IN reference to your letter of 31st ultimo (No. 80—B—258), I have the honour to state,—

1. That the results intended to be attained by any invention are,—greater safety in using cannon of all sizes; cheapness in manufacturing them; facility of moving them, in consequence of greater lightness of construction; and the possibility of making cannon so powerful as to render all iron or steel-plating useless as protection to ships of war.

2. That "the estimate cost of the invention, in a state to be introduced into the service," is about 2,000*l.* for a cannon large enough to sink the "Warrior" by three shots, and about 150*l.* for a cannon a little stronger and better than the Armstrong 100-pounder.

 3. That

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3. That the sum I require for the assignment of my patent to the Secretary of State, is five hundred thousand pounds (500,000 *l.*); or for a license to manufacture the sum of 1 *s.* per hundredweight of cannon made on my plan by Government officers in Royal Arsenals or Foundries.

Should I supply a gun worth 3,000 *l.* or 4,000 *l.* for experiment, I trust that Rule 8 will not be enforced, and that the gun will be returned to me after a reasonable time, say two months, and that it will not be fired more than 100 times. Without some assurance of this kind, I fear I cannot give the gun, not from any objection to present Her Majesty's Government with so valuable a thing, but from absolute inability to afford it.

I have, as directed, supplied the Secretary of the Ordnance Select Committee with a description of my invention.

I have, &c.
(signed) *T. A. Blakely.*

The Under Secretary of State,
War Office, Pall Mall, S.W.

Army and Navy Club,
Sir, 22 January 1861.

Having applied to the Secretary of State for permission to lay before the Ordnance Select Committee an invention for making very strong cannon of all sizes, even up to that necessary to project shot through both sides of the "Warrior," I have been directed to comply with some printed instructions which have been given to me.

Rule No. 3 of these is, that a written description of the invention is to be left with you. I have the honour, therefore, to enclose a printed one, hoping that will be sufficient.

You will perceive, Sir, that the invention is one which a former Committee reported against in most decided terms. The Secretary of State is aware that such is the case.

My hopes of being able to persuade the present Committee to come to a more favourable conclusion, are based on the fact of my being now able to inform them of several successful experiments, and of many details which I did not bring under the notice of former Committee.

I shall feel much gratified, if permitted the honour of explaining my views more fully to the Committee in person, whenever they think them worthy of consideration.

I have, &c.
(signed) *T. A. Blakely.*

(80—B—272.)

Sir, War Office, 31 January 1861.

I am directed by the Secretary of State for War to acknowledge the receipt of your letter of 22d instant, in which you state the sum for which you are prepared to make over the assignment of your patent for building up guns to Her Majesty's Government, and I am to request that you will forward to this office, for his Lordship's perusal, a copy of the specification of the patent in question.

I am, &c.
(signed) *B. Hawes.*

Captain Blakely,
Army and Navy Club.

Army and Navy Club,
My Lord, London, 1 Feb. 1861.

Agreeably to the request contained in the letter, dated War Office, 31st January, No. 80, B. 272, I enclose a copy of the specification of my invention, patented 27th February 1855, of a mode of building up cannon in concentric tubes, the outer ones compressing the inner ones.

In May 1855, I would remind your Lordship, I laid before the Ordnance Select Committee detailed calculations to determine the exact degree of tension each tube should have. I also sent several sample cannon to Woolwich. The Ordnance Select Committee on 11th June 1855, reported my views to be wrong, and declared that "cannon so constructed could never be considered safe." However, I sent another gun which showed such endurance, that the superintendent Royal Gun Factory, the member of the Committee who had drawn up the adverse report on my plan, began to doubt the correctness of his first judgment, and asked leave to try my system on a 68-pounder gun, and a 10-inch gun.

This he did in 1857, and the guns were fired a few years afterwards. This delay alone goes far to prove that no person then in office looked on the plan as his invention. The following letter, however, contains positive evidence that I was then acknowledged as the inventor.

(80—B—52.)

"Sir, War Office, 27 Nov. 1858.

"I am directed by Secretary Major-General Peel to acknowledge the receipt of your letter of the 15th instant, and in reply I am to inform you that the 68-pounder gun strengthened with rings on your system, is intended to be tried in comparison with a 68-pounder gun constructed by Mr. Holroyd, which has not yet been supplied. The trial of the 10-inch gun will take place as soon as some diaphragm shrapnell shells, which are being prepared to fire from it, are ready.

"I am to add, that due notice will be given to you of the time and place of these experiments.

"I have, &c.
(signed) "*Hardinge.*

"To Captain Blakely."

The due notice promised was, from some accidental cause probably, not given, and immediately after the proof of these guns, your Lordship ordered Sir W. Armstrong to construct some hundreds on the same plan, without reference to me. He totally failed, as your Lordship has acknowledged.

Colonel St. George, President of the Ordnance Select Committee, was allowed to try, and he succeeded but little better.

Captain Caffin, R.N., an officer likewise attached to the War Office, and likewise cognisant of my plans, made an attempt somewhat similar, and failed.

In July last, your Lordship asked me to send in plans, and directions for utilizing the iron cylinders cast for Sir Wm. Armstrong. I consented, but warned your Lordship that I did not anticipate success with them, as they were cast in a defective manner. To Captain Caffin I was equally

equally explicit, expressing my opinion that the cylinders should be remitted, and cast into better forms.

I offered your Lordship cast-steel or wrought-iron cannon built upon my plan, and at a much less price than is paid to the Elswick Company. You refused this offer, and confined my experiments for Government to defective cylinders, and a cast-iron gun 70 years' old.

After I had sent your Lordship the detailed drawings and directions for strengthening the cylinders I wished to go abroad. Your Lordship wrote to me on 23d August, pressing me to stay in England and personally superintend the building of the guns; I, of course, complied.

For six months, my Lord, have these cannon been kept unfinished, and during that time my plans have been copied in wrought-iron by Sir W. Armstrong so exactly, that it is difficult to distinguish between one of his new muzzle loading 100-pounde and one of my guns.

I am convinced your Lordship will not permit Sir W. Armstrong's defective cylinders to be passed off as my invention, and my plans to be carried out by him and represented as his; and that the possibility of this happening need only be pointed out to secure your Lordship's decisive interference. It is under these circumstances that I ask your Lordship to take a license under my patent on the moderate terms I mentioned in my last letter.

I have, &c.
(signed) *T. A. Blakely.*

The Right Honourable
the Lord Herbert,
&c. &c.

P.S.—February 2d.—I yesterday had the privilege of laying my views on the construction of cannon before the present Ordnance Select Committee, a former one having pronounced them unsound. I have had the great satisfaction of hearing that judgment reversed.

I can now truly say that every scientific body to whom I have submitted my discovery, acknowledge that I have proved that cannon to be strong must be built up of concentric tubes, the inner ones compressed and the outer ones stretched to a definite degree.

I was the first person to suggest this method of construction to Her Majesty's Government.

I have spent five years, and several thousand pounds, to convince Her Majesty's Government of the value of my invention.

Yesterday this value was acknowledged for the first time by the Ordnance Select Committee. I feel sure your Lordship will gladly confirm its opinion.

(80—B—276.)

Ordnance Select Committee.

4 February 1861.

The Committee have the honour to report, for Lord Herbert's information, that at the request of Captain Blakely, they invited him to attend their meeting of the 1st February, and personally explain his views with respect to the manufacture of cannon, or, as he expressed it in a letter, dated 22d January, his "invention for making very strong cannon of all sizes, even up to that necessary to project shot through both sides of the 'Warrior.'"

Captain Blakely on this occasion added nothing to what he has repeatedly urged in his publications, viz., that the true method of proceeding is to shrink one ring or coil of metal in another, with a certain calculated tension; and he produced a pamphlet published in 1858 as embodying his views.

The Committee pointed out to him that this, and no other, is the principle employed in the manufacture of the Armstrong guns, and it appears to them that whatever dispute there may be as to originality or priority of invention, and the use of terms between Captain Blakely and Sir W. Armstrong, there is little or none in the matter of fact. Both make, or propose to make, strong guns in the same way; nor is the principle in anyway new.

When asked to explain his views as to a cannon which should project shot through both sides of the "Warrior," he only expressed his opinion that this would be in the power of a 12-inch gun, projecting an elongated shot weighing about 700 lbs., with 70 lbs. of powder. He further declared that such a gun could be made, to weigh not more than 10 tons, and that he could name more than one firm ready to tender to supply such a gun, upon the terms of receiving no payment if it should burst in proof with a double charge.

The Committee are persuaded that no gun of 10 tons weight would stand such a charge or such a projectile, and disbelieve that any responsible firm is to be found to tender to supply one under guarantee that it shall stand proof with charge of one-fifth the weight of the projectile; nor do they think it probable that it would produce the effect expected by Captain Blakely. But it would undoubtedly be a tremendous weapon, and, notwithstanding the weight, might be worth introduction, if produced.

They do not think it desirable that the Superintendent of Royal Gun Factories should give up valuable time to the elaboration of a 10-ton gun, but respectfully suggest that an intimation be conveyed to Captain Blakely that if he can procure a firm of known character to tender to make a 12-inch gun to stand a service charge of one-tenth weight of the projectile, or 70 lbs., and a proof charge of two-tenths; the gun not to weigh more than 10 tons, and to be guaranteed, the Secretary of State will be prepared to take such tender into consideration. The drawings to be approved by the Ordnance Select Committee.

(signed) *J. St. George.*

(80—B—275.)

Sir, War Office, 16 February 1861.

I am directed by the Secretary of State for War to acknowledge the receipt of your letter of the 1st instant, covering a specification of the invention you have patented for building up cannon in concentric tubes.

In reply, I am to inform you that Lord Herbert declines to take any license from you under this patent; but should you be able to induce any firm of known character to tender to supply a 12-inch gun capable of enduring a service charge of one-tenth the weight of its projectile, or 70 lbs. of powder, and a proof charge of two-tenths, and of a weight not exceeding 10 tons, his Lordship will

App. No. 64.

will be prepared to take such tender into his consideration.

It will, however, be necessary that the drawings from which this gun may be made should be approved by the Ordnance Select Committee, and that the firm tendering for its supply should guarantee its efficiency in all respects as a condition of payment.

I am, &c.
(signed) *B. Hawes.*

Captain Blakely,
Army and Navy Club.

Army and Navy Club,
My Lord, 23 February 1861.

THE 70-pounder cylinder your Lordship was good enough to allow me to have down at Liverpool to strengthen, I found to be different in diameter at one part from the sketch furnished to me; I have consequently been obliged to order fresh hoops to be made for that part.

Meanwhile, the Messrs. Naylor, Vickers, & Co., of Sheffield, who supplied the steel jacket for the main part of the gun, have become impatient for its price, and I have the honour, therefore, to request your Lordship will kindly order them to be paid. Their bill amounts to 138 *l.* 15 *s.* I am boring the gun out to a diameter of nine inches exactly. Should it succeed, therefore, it may serve as a model for converting the other cylinders into rifled 200-pounder guns.

Should your Lordship wish it to be tested for strength solely, it will be necessary to have some 9-inch both made.

The 56-pounder I have not yet received.

I regret that I cannot give plans of the 700-pounder 12-inch gun. I propose, without some guarantee, that the plans shall not be copied without my consent.

I have, &c.
(signed) *T. A. Blakely.*

The Right Honourable
the Secretary of State,
War Office.

(80—B—279.) War Office,
Sir, 5 March, 1861.

I AM directed by the Secretary of State for War to acknowledge the receipt of your letter of the 23d February, and in reply I am to request that you will state the cost of strengthening the 70-pounder cylinder and the 56-pounder gun therein referred to, and I am to state that payment cannot be made until the service has been actually executed.

In regard to the concluding paragraph of your letter, I am to forward to you the enclosed copy of the rules observed by this department in regard to inventions, and I am to inform you that Lord Herbert sees no reason for making an exception to Rule 9 in your case, but that he can only assure you that no undue advantage will be taken of any plans you may think proper to submit.

I am, &c.,
(signed) *B. Hawes.*

Captain Blakely,
Army and Navy Club.

War Office, 1 July 1863.

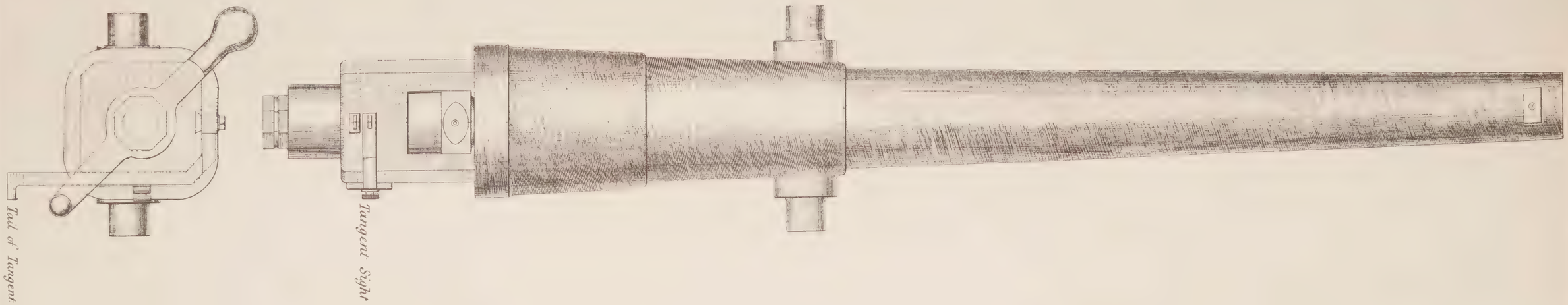
Alex. T. Tulloh,
Director of Ordnance.

Appendix, No. 65.

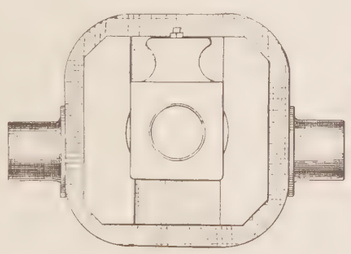
DRAWING of original Armstrong Gun, referred to in Report of Sir W. Armstrong, dated 14 July 1855 (*See opposite*).

DRAWING OF ORIGINAL ARMSTRONG GUN.

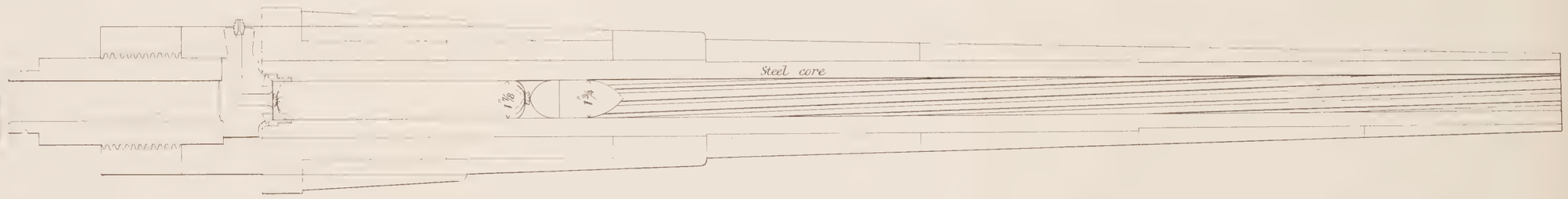
Referred to in report of Sir W. Armstrong dated 14 July 1855.
(vide appendix Ordnance Report page 158)



Section behind Breech Piece



Section through Gun & Tightening Screw shewing Breech Piece in its place



Note. The Original is Colored

Scale

W. G. Armstrong

Nº 487_Ordered, by the House of Commons, to be printed, 23 July 1863

Appendix, No. 66.

PAPER delivered in by Mr. *T. G. Baring*, 6 July 1863.

LETTER from Mr. *C. H. Pennell* to the Under Secretary of State for War. App. No. 66.

Sir, Admiralty, 24 November 1860.

WITH reference to Captain Caffin's letter of the 22d instant (No. 73-3-1437 P), stating that the War Department could supply the Royal Navy in a short time with cast-iron guns, rifled and strengthened as the French, provided, like the French, they were fired with very light charges only, I am commanded by my Lords Commissioners of the Admiralty to acquaint you, for the information of Mr. Secretary Herbert, that after the report of the Ordnance Select Committee, they consider it unadvisable to introduce into the service guns of this description, as, in the event of any unfortunate accident occurring, the confidence which the seamen now have in the safety of their guns might be destroyed.

As regards the last portion of Captain Caffin's letter, wherein it is stated that a proportion of Armstrong's 100-pounder guns, not yet begun, could be made as muzzle-loaders if considered desirable, I am to acquaint you that my Lords would wish to be furnished with further information without delay, before giving any answer, as they do not quite understand it, and especially as to whether the projectiles will be covered with lead, the same as breech-loaders.

The Under Secretary of State for War,
Pall Mall.

I am, &c.
(signed) *C. H. Pennell.*

Appendix, No. 66*a*.

PAPER delivered in by Mr. *T. G. Baring*.

App. No. 66*a*.

Report on the Trial of Whitworth Cannon.

H. M. S. "Excellent,"
Sir, Portsmouth, 4 Feb. 1861.

With reference to your Memorandum of the 24th ultimo, informing me that their Lordships approve of the experiments with the Whitworth gun taking place on the 28th ultimo,

I have the honour to inform you that on the 29th ultimo I proceeded outside the harbour, and fired 18 rounds from this gun, trying it under the circumstances of loading both at the breech and muzzle, and I also commenced, on the 30th ultimo, firing at the plates attached to the side of the "Sirius;" but after the third round a fracture was discovered in the bore of the gun (as reported in my letter of the 31st ultimo), which obliged us to discontinue firing.

I beg herewith to forward a copy of the above experiments, and to state my opinion that Mr. Whitworth's system of loading at the breech is not a desirable one, as it is very susceptible of injury, and requires more care in handling and using than it would be possible on service to give it.

In reference to the report of the trial, it will be seen that on two occasions the gun, from accidental circumstances, could not be fired for a considerable time, and one of these delays was caused by a piece of grit or dirt (most probably from the funnel), which furrowed up the worm of the screw, and prevented the breech piece from going home, as the screw, when the breech is open, is very much exposed. I consider this would very likely frequently happen; and added to this, we found a difficulty (when the gun had 11° of elevation) in keeping the breech (from its weight) close to the gun, in order that it might be screwed up after loading.

The mode of priming is also objectionable, and there is the fear of the projectile being pushed, in the hurry of an action, too far up the bore, thus causing a space between it and the cartridge, which would affect the range, and bring the effect of the charge more suddenly upon the projectile, and cause a greater strain on the gun. Under the whole of these circumstances, then, I consider that Mr. Whitworth's breech-loading apparatus is very ill-adapted for actual service.

With respect to its being constructed and used as a muzzle-loading gun, I am of opinion that it is very doubtful whether it could be used as a muzzle-loader, as it will require experiments to prove whether, after being fired a number of rounds, the projectile could be forced home.

We found at first that it required no force, but after a few rounds, a hard deposit (notwithstanding the lubricating wads) formed in the bore, and although we used the dry sponge on each occasion of loading at the muzzle, we had latterly to use a wet one, and some force to get the projectile home.

This I intended to have proved more fully by firing 30 or 40 rounds from it (loading at the muzzle), had not the gun been fractured and rendered useless.

The projectile we found also started occasionally in the bore from running out hard against the slide, and at one time as much as eight inches.

We afterwards, on each round, assured ourselves that the projectile was home by entering the rammer at the muzzle. If ever this gun is used as a muzzle-loader, it will be necessary to use wads over the projectile.

As regards the fracture, I beg to state that, as mentioned in my letter of the 15th November 1857, I never considered these guns safe ones, and I believe there is a great doubt as to any rifled gun with a severe twist possessing this essential quality, when the surface of the projectile is of hard metal, such as wire or hardened steel. My conviction is, that from the first shot fired, the gun is weakened, and although it may be used for a considerable time, before showing its weakness, that at length it will go. The deepest and widest part of the fracture is near the point of the flat-headed projectile when the gun is loaded.

The recoil of the Whitworth gun was remarkably moderate throughout; we had only one fair shot against the plate, which, strange to say, penetrated only 2·8 inches. This must be owing to the latter being of a better quality than those on the "Trusty's" side, as well as being half-an-inch thicker, and the projectile only 70 lbs. weight instead of 80 lbs., as used against that vessel. The plate was well supported by a wooden knee, immediately behind the blow given by the projectile.

I have, &c.
(signed) *R. S. Hewlett*,
Captain.

Vice-Admiral H. W. Bruce,
Commander in Chief.

Appendix, No. 67.

LETTER from Mr. *Whiffin* to the Right Hon. *W. Monsell*, M.P. App. No. 67.

Sir, War Office, 6 July 1863.

THE Committee, of which you are chairman, having requested that the letter dated the 16th ultimo, addressed to you by Mr. J. G. W. Rendel, on behalf of the Elswick Ordnance Company, and criticising certain statements signed by me, should be referred to me for any observations I might have to offer, I beg to state that I have obtained the permission of the Earl De Grey and Ripon to address you on the subject of the letter in question.

I beg in the first place, to assure the Committee that the reopening of the much vexed question of the cost of manufacturing Armstrong guns and projectiles at the Government manufactories at Woolwich, compared with the prices paid to the Elswick Ordnance Company, was not a voluntary act on my part. I merely submitted to the Committee, having first obtained the permission of the Secretary of State to do so, certain returns with which you, as chairman of the Committee, requested that you might be furnished. So far as I am concerned, I should also have been quite content to have allowed the question to rest on the evidence taken before your Committee last session.

The statement submitted by me, App. No. 44, is, so far as No. 2 is concerned, merely a compilation from previous returns furnished to the Committee. See pp. 236 and 233 of the Committee's first report.

In furnishing the information required by you, I carefully, as I imagined, avoided re-opening the question of comparative cost, by adopting the prices that had been submitted by the Assistant Superintendent Royal Gun Factories; and I adopted those rates, as there had been considerable discussion before your Committee, upon the principle upon which they had been arrived at; I moreover selected the return, upon which the general charges were distributed according to the amount of direct labour, as I had during last session explained to the Committee my reasons for considering such distribution the most correct. I gave also, on return No. 44, a reference to the document from which I had obtained the prices; I was therefore under the impression that there would be no ground for misapprehension, as the statement, which is now so much objected to on the part of the Elswick Ordnance Company, clearly shows the source from which the details were obtained.

Had I adopted the results shown by the balance of the Royal Gun Factories, 1861-62, it would have placed the rates paid to the Elswick Ordnance Company in a still more unfavourable comparison with those at Woolwich. I was of opinion that by adopting the rates which had already been submitted to the Committee, and with which the Committee were perfectly acquainted, would save further controversy, and would be preferable to introducing entirely new rates, obtained from the audited balance sheets for the year ended 31st March 1862.

As the general question in regard to what is the correct principle upon which the balance sheets of the Government manufacturing establishments should be prepared, I venture the following observations, with the view of eliciting, if possible, an opinion on the points at issue.

The balance sheets of the manufacturing establishments of this department have, for the first time, been presented in a collected form. The object principally in view is to furnish Parliament with a statement showing that the money voted each year for the services of these establishments, has been duly accounted for. In order to arrive at this result, all that is required is to show the actual cost, for the year, of the several articles produced. Upon these results the Secretary of State can base his calculations as to the amount to be provided in the Army Estimates for manufacturing a certain number of guns and projectiles; actual cost of labour, materials, and establishment or indirect charges, being all that is essential for this object.

A further consideration in these balance sheets is to enable the Secretary of State to ascertain whether the rates at which the several articles are being manufactured can be favourably compared with the rates charged for similar articles supplied by contractors. In this view of the balance sheet, all that is required is to add to the actual cost certain charges which are elements in the amount paid to contractors, and which are not items of actual expenditure in the Government accounts; these items consist principally of charges to cover depreciation of plant and for interest on capital.

App. No. 67.

In regard to the charges for depreciation of plant, it has been urged that 10 per cent. on buildings and machinery should be raised against the several establishments. This uniform rate has not been adopted, as it was considered, so far as Government establishments are concerned, to be excessive; and a rate of 5 per cent. only on buildings, and 10 per cent. on machinery, has been substituted; but even by adopting these modified rates, any calculations founded thereon would prove entirely fallacious, as we assume that buildings and machinery would only last 20 and 10 years respectively; a period which is quite inconsistent with actual experience, as certain buildings at Woolwich, which were erected more than a century since, are, for all practical purposes, as sound as ever.

It is quite understood why private firms contend for these high rates of depreciation; it tends to augment fictitiously the apparent cost of the articles made in the Government factories, and, at the same time, excessive rates of charges for depreciation become a source of profit to the contractor, as he invariably makes the consumer pay for it in the price of the article.

In regard to the buildings and machinery in the factories belonging to this department, it is to be observed that the cost of their maintenance is charged to the productions of the year; consequently, the plant, having its fair wear and tear continually made good, is, at all times, kept in a state of the highest efficiency, which is, I think, a conclusive argument against adopting an excessive rate of depreciation.

In regard to the observation contained in the third paragraph of Mr. Rendel's letter, in which he states that no charge has been raised on the balance sheet of the Royal Gun Factory for depreciation and interest, it may be remarked that it was decided, after due consideration, not to introduce these items into the actual account, but to state the effect, so far as depreciation is concerned, by means of a memorandum on the account, showing the rate per cent. by which the productions would be enhanced were this element taken into consideration.

The effect of charging depreciation on the plant is shown by means of a separate capital account, and the result is that the cost of productions is increased by 4·556 per cent. *See* Memorandum on the Balance Sheet, p. 19, Parliamentary Paper, No. 176, Session 1863.

The question of charging interest on the capital has been well considered, and it has been thought advisable to omit the item altogether from these balance sheets. If, however, the principle were adopted, the question would arise whether both invested and floating or working capital should be liable to interest, or whether the former only should be so charged.

If it be determined to introduce charges for interest in the balance sheets of the manufacturing establishments of this department, it should, in my opinion, be calculated on the invested or general capital, and not on the floating or working capital. The former comprises the amount invested in lands, buildings, machinery, and stores, including those in a semi-manufactured state; the floating capital merely consists of such amount as would be required for the payment of wages and other expenses, and considering that the Elswick Ordnance Company has been paid monthly for work in progress, the floating capital of that establishment has, to a great extent, been provided by the Government, and it would therefore be unfair to raise a fictitious charge of this nature against the guns manufactured at Woolwich.

In regard to the amount to be charged on the invested or general capital, it might, if so determined, be fixed at 3½ per cent., which, on the capital of the Royal Gun Factories, as shown at pp. 19 and 36 of Parliamentary Paper 176, would be as under:—

	£.	£.
Buildings - - - - - - - -	67,369	
Machinery - - - - - - - -	157,064	
		224,433
Stores - - - - - - - -	83,872	
Semi-manufactured articles - - - -	97,035	
		180,907
	£.	405,340

Which at 3½ per cent. amounts to 14,186 *l.* per annum, or 3·35 per cent. on the total productions for the year 1861–62. The amount to be charged for interest should be introduced into the balance sheet as a memorandum only, in the same manner as has been done in respect to the depreciation.

It appears, therefore, that, irrespective of charges for insurance, wharfage, and other trifling items which are elements of expense to contractors, but are not such to the Government, the only addition to the actual cost, as shown by the balance sheet, would be, so far as the Royal Gun Factories accounts 1861–62 are concerned, 3·35 per cent. for interest on capital and

and 4·56 per cent. for depreciation on plant; together equal to 7·91 per cent., and the result would be as under:— App. No. 67.

	110-Pounders.	20-Pounders.	12-Pounders.	9-Pounders.
	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Actual cost per balance sheet, the general charges being distributed over the direct labour only - -	354 17 1	106 – –	71 6 8	56 5 3
Add,—7·91 per cent. for depreciation and interest - - - -	28 1 4	8 7 9	5 12 8	4 9 –
Total Cost per Gun - - £.	382 18 5	114 7 9	76 19 4	60 14 3

From the above it appears that the rates adopted in Return No. 44, are considerably higher than the actual cost for the year, plus the assumed charges for depreciation on plant and interest on capital.

The rates adopted in the return in question (No. 44) show a difference in favour of Woolwich of 42·24 per cent. If, however, the higher rates, calculating the general charges on labour and materials combined, as contended for by the Elswick Ordnance Company (*see* Letter dated 20 March 1862; Report 1862, p. 151) were taken, the per-centage in favour of Woolwich would be 37·59; thus—

Guns.	Elswick Ordnance Company.			Royal Arsenal.	
	Numbers.	Rates.	Total.	Rates.	Total.
		£. s. d.	£. s. d.	£. s. d.	£. s. d.
110-Pounders	209	700 – –	146,300 – –	424 13 1	109,985 8 7
	50	588 5 –	29,412 5 –		
25 Pounders	1	230 – –	230 – –	180 4 7	5,587 2 1
	30	220 – –	6,600 – –		
12-Pounders	69	170 – –	11,730 – –	83 14 9	7,536 7 6
	21	143 – –	3,003 – –		
		£.	197,275 5 –	- £.	123,108 18 2
Difference between Woolwich and Elswick Rates, equal to 37·59 per cent. - -			- - -	- -	74,166 6 10
		£.	197,275 5 –	- £.	197,275 5 –

Again, had the comparison been made between Elswick and Woolwich rates, according to the balance-sheet 1861–62, plus 7·91 per cent. for depreciation on plant and interest on capital the statement would have been thus :—

Guns.	Elswick Ordnance Company.			Royal Arsenal.	
	Numbers.	Rates.	Total.	Rates.	Total.
		£. s. d.	£. s. d.	£. s. d.	£. s. d.
110-Pounders	209	700 – –	146,300 – –	382 18 5	99,176 9 11
	50	588 5 –	29,412 5 –		
25-Pounders	1	230 – –	230 – –	114 7 9	3,546 – 3
	30	220 – –	6,600 – –		
12-Pounders	69	170 – –	11,730 – –	76 19 4	6,927 – –
	21	143 – –	3,003 – –		
		£.	197,275 5 –	- £.	109,649 10 2
Difference between Woolwich and Elswick Rates, equal to 44·41 per cent. - -			- - -	- -	87,625 14 10
		£.	197,275 5 –	- £.	197,275 5 –

App. No. 67.

It should be remembered, that in making the foregoing comparisons respecting the guns, I have only been able to do so with reference to the limited sum of 197,275 *l.*, whereas the total sum paid to the Elswick Ordnance Company for guns, is upwards of 400,000 *l.*

So far as regards Mr. Rendel's protest against the miscellaneous productions of the Royal Gun Factories, taking the same per-centage as the guns for general charges, it appears to me that this question is so intimately connected with the principle upon which such charges are to be distributed, whether uniformly upon direct labour only, or upon direct labour and material combined, that I do not consider there is any necessity to do more than refer to my evidence of last Session, and to what I have written in the early part of this paper upon this subject. It may be well to mention, that in answer to Question 2388 (*see* the Committee's first Report, pp. 118 and 119), I stated that, out of an assumed total for general charges of 58,000 *l.* for the year 1861–62, the amount applicable to guns alone would be about 22,000 *l.*, and this opinion has been in a great measure confirmed by the results produced by the balance sheet for that year.

In conclusion, I would remark, with reference to Mr. Rendel's assertion, that the strength of the Royal Gun Factories had been devoted "to the guns, and not upon the miscellaneous articles;" that so far from that being the case, the amount expended upon the miscellaneous productions for direct labour was, for the year 1861–62, considerably in excess of the amount expended for that service in the manufacture of guns alone.

I have, &c.
(signed) *H. W. S. Whiffin,*
Assistant Accountant General.

To the Right Honourable
William Monsell, M.P., Chairman,
Select Committee on Ordnance.

Appendix, No. 68.

App. No. 68. LETTER to the Right Honourable *William Monsell,* M.P., Chairman of Committee on Ordnance.

Sir, Redhill, 8 July 1863.

HAVING been present when Mr. Baring stated in his evidence to the Committee, on Monday last, that at the time the Government offered to furnish the Admiralty with a supply of cast-iron guns rifled on my system, he was not aware that any proposal had been made to apply my system to any other than cast-iron guns, I beg to be allowed to state that I had several times previously applied to the authorities for stronger guns to be tried on my plan, but without success. I refer to my letters of the following dates, viz.:—

To the Secretary of State for War, 1 April 1859.

To the Secretary of the Ordnance Select Committee, 18 July 1859.

To the Secretary of the Ordnance Select Committee, 7 May 1860.

To the War Office, 25 June 1860.

To the Ordnance Select Committee, 27 July 1860.

I wish further to state, that even up to the present time, I have had no opportunities of demonstrating the advantages of my system of rifled ordnance on anything like equal terms with other inventors. I allude more particularly to Mr. Whitworth and Sir William Armstrong.

In reply to my application of 27 July 1860, I was informed that the Ordnance Select Committee had recommended the construction of a heavy brass gun of 6 ½ inches bore for the trial of my system in comparison with the Armstrong shunt. For this gun I was desired to furnish drawings of the rifling I wished to have applied. This I did at once; but the gun has never been made.

On the 7th May 1862, I applied to the War Office for a wrought-iron gun of a specified weight and bore, designed as a naval broadside gun, in conformity with certain views communicated to me in an interview with several of the Lords of the Admiralty.

This request was not complied with, but I was informed that a wrought-iron 7-inch gun would be made and rifled according to the views of the Ordnance Select Committee, and that from this gun some of my projectiles would be fired. On learning the manner in which this gun was to be rifled, I at once represented to the War Office that the rifling would not be suitable for my projectiles. This opinion has been confirmed by the trials which I have recently made with this gun. This gun is called the Ordnance Select Committee's gun.

I beg to be allowed to state that the only way of arriving at a fair judgment as to the merits of the several systems of rifled ordnance considered worthy of further trial is, in my opinion, to allow each inventor to have a gun constructed for him at the Royal Gun Factories, but all to be of a given weight, say, six or seven tons. Each inventor, however, to be allowed to decide for himself the size of the bore and the nature of rifling. The necessity of this is obvious, when it is borne in mind that while, for example, Mr. Whitworth adopts a very small bore in proportion to weight of gun, so as to use very long projectiles, it is my opinion that it is desirable to have the bore as large as possible, for the purpose of using it for round shot like a smooth bore, as well as a rifled gun with short elongated projectiles. In a competitive trial, it would then have to be considered which system offered the greatest advantage generally for the service.

Having understood that it is too late to appear as a witness before the Committee, I have taken this opportunity of submitting the above remarks to the Committee, and shall be glad if they will permit what I have stated to appear in their report.

I have, &c.
(signed) *Bashley Britten.*

Appendix, No. 69.

(80—B—73.) App. No. 69.

CORRESPONDENCE between the War Office and Captain *Blakely*, respecting the alleged infringement of his Patent for Improved Ordnance by Sir *W. Armstrong.*

Sir, 24, Wilton Place, S.W., London, 14 April 1859.

I HAVE the honour to inform you that I have a patent, dated February 27th 1855, for the manufacture of cannon on a plan which I am informed is about to be adopted by Her Majesty's Government, and for carrying out which, a factory is said to be in the course of erection in Woolwich Arsenal; I allude to the so-called Armstrong Gun Factory.

I have the honour to request that you will cause to be paid to me a royalty of 20 *l.* for each gun so made in any of the Royal Arsenals. This sum will not appear large when it is considered that without the strength, to be obtained only by my plan, accuracy is of no use, as was proved by the bursting of Mr. Joseph Whitworth's two rifled canon. Mr. Whitworth is now making two on my plan. I have the honour to remind you, sir, that I have spent several years of my life in the elucidation of this mechanical question, and that I have carried on numerous and costly experiments at my own expense. A year ago, while my plans were still considered impracticable by the Ordnance Select Committee, you were kind enough to acknowledge my efforts so far as to offer me a sum of money. Now that my plans are finally approved and adopted, therefore I feel that my appeal to you for a full acknowledgment of the part I have taken in bringing them to the notice of Government, will not be made in vain.

To remove all doubt as to the identity of Sir William Armstrong's method of obtaining the necessary strength and my method, I enclose copies of one or two descriptions of each, which have appeared from time to time.

I have, &c.

To Her Majesty's Secretary of State for War, &c. &c. &c. (signed) *T. A. Blakely*, Captain.

EXTRACT from the Provisional Specification No. 431, left by Captain Blakely at the office of the Commissioners for Patents on the 27th February 1855:

"The improvements relate, first, to forming guns of an internal tube or cylinder of cast iron or steel, inclosed in a casing of wrought iron or steel. I prefer to form the surface of the inner tube somewhat conical, the greatest diameter being just in front of the trunnions and tapering both ways, and to apply the outer casing in the form of collars or rings driven thereon; and in some cases I apply two or more layers of such rings, according to the strength sought to be obtained, the trunnions being of one piece with one of the rings

"I also form such outer casing of wire or rod wound spirally in one or more layers around the inner cylinder or tube."

EXTRACT from the Provisional Specification No. 401, left by Sir William Armstrong at the same office two years later:

"The improvements relate, first, to forming guns with the internal tube or cylinder of wrought iron or gun metal in one piece, surrounded by one or more cylindrical casings of wrought iron, or gun metal shrunk upon the internal cylinder."

The following description of Sir William Armstrong's gun appeared in the "Mechanics' Magazine" of February 25th, 1859, and in all the London papers of February 28th:—

"The new gun is formed of an internal steel tube, bound over with strips of rolled iron, laid on spirally."

P.S.—Sir William Armstrong being under the impression that the mere substitution of the inferior material, wrought iron for steel, in the internal tube, will enable him to evade my patent, I am about to commence legal proceedings against him, but communicate to you, sir, this intention, in case you should wish to avoid the publicity of a trial whereby the secrecy of the method of manufacture must be violated. If I might presume to make a suggestion, I should point out two ways of avoiding a public trial, viz., the purchase of my patent rights by the Government, or the issuing of a command to Sir William Armstrong not to defend an action, in which his cause is so manifestly unjust. To facilitate the latter arrangement, I am willing to forego all patent rights or royalties, on guns now absolutely being constructed by him, and for which the price is fixed.

I have, &c.
(signed) *T. A. Blakely.*

App. No. 69.

(80—B—73.)

War Office,
Sir, 21 April 1859.

I AM directed by Secretary Major General Peel to acknowledge the receipt of your letter of the 14th instant, relative to an alleged infringement by Sir William Armstrong of a patent taken out by you in the year 1855, and to inform you, that after investigation of the subject, a further communication will be addressed to you.

I have, &c.
(signed) *Rosslyn.*

Captain Blakely,
24, Wilton-place, S. W.

(80—B—82.)

24, Wilton-place, S. W.. London,
Sir, 26 April 1859.

I HAVE the honour to acknowledge the receipt of the letter dated War Office, 21st April, and to express my thanks for the patient consideration you are giving my letter of the 14th instant. I enclose copies and extracts from some papers which will, I trust, greatly facilitate your decision.

Marked (A.), is a letter written by Sir William Armstrong to the "Times," in January 1857, describing his gun thus:—

"With a view to strength and durability the gun is composed internally of steel, and externally of wrought iron, applied in a twisted or spiral form, as in a musket or fowling piece."

If you will have the goodness to compare this with my specification of 1855, which I also enclose, you will see that I have a patent for this method of construction. I sent the above letter to a barrister in January 1857, and informed Sir William Armstrong of his opinion, that my patent included his gun. Marked (B.), I enclose Sir William Armstrong's reply, promising to communicate with me before dealing "commercially" with his invention, and asking me not to stop his experiments. I confided in his promise (and in his protestation, made to me in 1856 at Newcastle, that his only object was the advancement of science), and did not, as I could have done, prevent his continuing his experiments. How far my confidence was justified you can judge for yourself, sir, if you will be good enough to read his specification, of which I enclose a copy, filed within three weeks of the above letter.

It is impossible to conceive a more palpable attempt to evade a patent. He thinks to do so by substituting an inferior material, wrought-iron for steel in the interior, and why? Certainly not because he was dissatisfied with the endurance of his former guns. In his letter to the "Times" he says,—

"In the course of the long series of experiments made with this gun it has been fired nearly 1,300 times without sustaining any permanent injury either in the breech-loading arrangement or otherwise. The only parts exposed to wear (and none are seriously so) are separable from the gun, and can with great facility be renewed.

"I am, &c.
(signed) "*W. G. Armstrong.*

"Elswick Engine Works,
Newcastle-upon-Tyne."

I am luckily, however, able to prove still more clearly that he found the first gun strong enough. In April 1856, Captain Younghusband communicated to the Royal Artillery Institution a description of the Armstrong gun, which I enclose, marked (C). We here learn that "Careful consideration was first given to the tensile strength of the various materials suitable for the construction of a gun, and some experiments were made on the strength of cylinders of wrought-iron, forged in the requisite form, and afterwards bored; the result of these experiments showed great uncertainty in the strength of the material, rendering it impossible to define the thickness necessary to resist a given charge of powder. Mr. Armstrong then decided upon, and ultimately completed a gun of which the following is a description:—A core, or internal lining for the gun, was formed of cast-steel, to which the requisite strength was given by encircling it with twisted cylinders of wrought-iron, made in a similar manner to gun barrels, and tightly contracted upon the steel core by the usual process of cooling after previous expansion by heat; the parts are then in that state of initial tension which is necessary to bring their entire strength into operation."

So it appears, that before hearing of my patent, Sir William tried wrought-iron, and abandoned it for steel, and that it was, after hearing of my patent, wherein I give steel the preference, that he returned to wrought-iron. Now, this can have been from no failing of the steel, for Captain Younghusband's paper concludes with the words—

"Mr. Armstrong believing the gun to be stronger than necessary, suggested its being returned to him to have it re-bored for a heavier projectile, and also to make some alterations in the rifling, by which he expected to obtain increased accuracy of fire. The gun was accordingly sent back to Newcastle."

I feel the most perfect confidence, sir, that you will not avail yourself, on behalf of Her Majesty's Government, of any such subterfuge to evade my patent rights, as this substitution of one material for another, particularly as there is a principle involved in the construction of these cannon, which I was the first person in England to discover, and to bring to the notice of Government, as Colonel Lefroy can inform you. I enclose copies of several pamphlets I have written on the subject, and beg, sir, that you will have the kindness to let some competent person compare my published views with the reasons given by Captain Younghusband, as those which guided Sir William Armstrong in adopting the method of construction. Not only have I written and been in constant communication with the War Office on the subject since 1854, but Mr. Robert Mallet communicated the same theory to the Royal Irish Academy in 1855, and his paper has been published. There can, therefore, be no shadow of novelty in Sir William Armstrong's plans of 1857. In 1856 I had even given him a sketch and a full description for the construction of a gun for me. The principle (of making several layers of metal each share in the strain) was to be carried out by forcing a small tube into the inside of the gun at the breech end. I cannot, of course, suspect that that plan has been copied, but I know that the principle is carried out by Sir William Armstrong in all his guns. This was publicly asserted by Mr. R. Mallet, F.R.S., at the Institution of Civil Engineers, at the evening meeting

meeting of the 1st ultimo. In conclusion, I will venture to remind you, sir, that I have spent four years, and about 1,500*l.* in bringing to light the principle of constructing cannon; and I confidently appeal to you to see that justice is done to me.

I have, &c.
(signed) *T. A. Blakely*,
Captain.

Secretary of State for War,
&c. &c. &c.

(A.)

LETTER published in the "Times," 3 January 1857.

To the Editor of the "Times."

Sir,

IN the latter part of 1854 I submitted to the Duke of Newcastle, then Minister at War, a proposal for a gun which I anticipated would possess great superiority over the common forms of light artillery, and I undertook, with his Grace's authority, to construct a field-piece in conformity with the plan I had suggested. The gun was accordingly soon afterwards made, and has since, during a period of nearly two years, been the subject of numerous experiments, partly upon the Ordnance firing ground at Shoeburyness, but principally under my own direction in this neighbourhood. I have hitherto avoided publicity in reference to these experiments; but, as matured results of much interest and importance have now been arrived at, and as other names are already before the public in connection with gun experiments made during the same period, I feel that I may now, without impropriety, give some information on the subject. With a view to strength and durability, the gun is composed internally of steel, and externally of wrought iron, applied in a twisted or spiral form, as in a musket or fowling-piece. The bore is nearly two inches in diameter, and is rifled. The projectile is a pointed cylinder 6½ inches long, and its weight is five-pounds. It is made of cast iron, coated with lead, and is fired from the gun with a charge of 10 ounces of powder; it contains a small cavity in the centre, and may be used either as a shot or a shell. When applied as a shell the cavity is filled with powder, and a detonating fuze is inserted in front, so as to fire the powder in the centre on striking an object. When used as a shot, the powder is omitted, and an iron point, which favours penetration, is substituted for the fuze. The gun is constructed to load at the breech, the object being not only to obviate the disadvantages of sponging and loading from the front, but also to allow the projectile to be larger in diameter than would enter at the muzzle, and thus to ensure its taking the impress of the grooves and completely filling the bore. The piece weighs five cwt., and is mounted upon a carriage which bears a general resemblance to that of an ordinary 6-pounder field gun, but which embraces a pivot-frame and recoil slide. A screw is also applied, not only for elevating and depressing the gun, but also for moving it horizontally, by which means great delicacy of aim is effected. The recoil slide has an upward inclination, which enables the gun, after running back, to recover its position by gravity; and its use is to relieve the pivot-frame and adjusting screws from injurious concussion. I shall now give some particulars of the experiments recently made with this gun on the coast of Northumberland, near the village of Whitley, under the official inspection of Colonel Wilmot. Fourteen shots were, in the first instance, fired from a distance of 1,500 yards at a timber butt 5 feet wide and 7½ feet high. Six of these were expended in finding the elevation proper for the distance, but after that was determined every succeeding shot hit the object without previous graze. The final elevation of the gun was 4° 26′, and the mean lateral distance of the shot marks, from a vertical line through the centre of the butt, was only 11½ inches. Persons who are conversant with artillery practice will be able to appreciate the accuracy of this firing; but for the information of those who are unacquainted with the subject, I may state that the ordinary 6-pounder field-piece, which, in point of weight, forms the nearest approach to the present gun, is perfectly useless at a distance of 1,500 yards, and is very uncertain even at 1,000 yards. It is only, therefore, with heavy artillery that a comparison can be drawn, and it will be sufficient to state that in tabulating the practice made with such ordnance, the deflections are invariably recorded in yards, whereas with this rifled gun they can only be properly given in inches. With respect to penetration, the following particulars will be regarded as equally remarkable, considering the small weight of the shot and the length of the range. The butt was three feet thick, and composed of six layers of rock elm bolted together so as to form a solid block. One shot passed entirely through; another struck near the edge and glanced; and the remaining six penetrated within a few inches of the opposite side. Shell firing was next tried, at a distance of 1,500 yards, the gun being fired at the same elevation and with the same charge as in previous practice at the butt. In this case, two targets were erected, one behind the other, so as to appear as one object when viewed from the gun, and a space of 30 feet was left between them. The front target was intended to exhibit the perforations of the shells before bursting, and the back one to show the effects of the fragments resulting from explosion. After some preliminary experiments, 22 shells were fired at the front target, and of these only one missed the object of aim. The following are the particulars: seventeen hit the first target direct, and burst behind it, the fragments penetrating the second one; three grazed and burst immediately in front of the first target, and perforated both with the pieces; one hit the bottom of the first target, and exploded in the ground, and the remaining one missed entirely and burst on some rocks nearly in a line beyond. A strong side wind was blowing at the time, and accounted for the deviation of this single shell. Four shells and three shots were then fired at an elevation of six degrees, from a distance of 2,000, or, more accurately, 1,964 yards. All these struck within the breadth of the target; but, the elevation being scarcely sufficient, they all fell a little short except one shell, which, ranging somewhat further than the others, hit the target, and burst as usual. The results of this shell-firing were as follow: the front target contained 51 holes and the back one 164, while the ground between and adjacent to the targets exhibited about 70 perforations by fragments of shells, the greater portion of which were afterwards recovered by digging. With respect to ranges exceeding 2,000 yards, I may state that on previous occasions the gun had been tried up

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to 3,000 yards—a distance that was reached with an elevation of 11 degrees, and the usual charge of 10 ounces of powder, or $\frac{1}{8}$th the weight of the projectile. By augmenting the charge the range is increased, but the accuracy is impaired, and I therefore adhere to the 10-ounce charge, which gives ample penetration, as the experiments at the butt will testify. I may also observe that the ranges obtained with this charge bear a favourable comparison with those of the heaviest round-shot guns fired with a much larger proportion of powder. It is a curious fact, and one which greatly increases the efficiency of the shells, that owing to the bursting charge requiring a minute space of time to mature its ignition after the firing of the fuze by impact, the shell is enabled to travel four or five feet after striking an object before disruption takes place. Hence, therefore, it acts as a shot before it bursts as a shell. When it perforates a target, the explosion may be seen to take place a few feet beyond, and when it grazes it has time to rise, and may be observed to burst after clearing the ground. If, therefore, it were fired against a ship, it would first penetrate the side in its entirety, and then, bursting, traverse the decks in fragments; or, if directed against troops, it would pierce the front line as a bullet, and operate like grape shot beyond. The shells explode with equal certainty whether the first substance struck be hard or soft, and, in fact, they even burst on the surface of water, providing the elevation of the gun be not too great. The bursting-charge is very small, but it suffices to break the shell into about 30 pieces, which pursue their forward course without too much dispersion. It is impossible to contemplate the results obtained with this gun without being impressed with the important part it is calculated to perform in warfare. Opposed to any ordinary field piece, it would be like the Minié rifle against the old musket, and no gun could be worked at an embrasure if a fire of shells were directed against it by one of these rifled pieces placed within the distance of a mile. In naval operations, also, guns of this description, but of larger size, might apparently be applied with great effect, more especially as a system of breech-loading, combined with a self-recovering recoil action, would be peculiarly advantageous in firing from port-holes. Even light 5-pounders, sending their shells from great distances through the sides of a ship and sweeping the decks with fragments of lead and iron, would produce very destructive effects, and a small swift steamer carrying a few such guns might prove a very troublesome opponent to a large ship of war. But if the dimensions of the gun were increased so as to adapt it for shells of 20 lbs. or 30 lbs., still more terrible injury could be inflicted at greater distances, and the ponderous artillery now used at sea would be of little service when opposed to the accurate and long-range firing of such rifled shell guns. It now only remains to be stated, that in the course of the long series of experiments made with this gun it has been fired nearly 1,300 times without sustaining any permanent injury either in the breech-loading arrangement or otherwise. The only parts exposed to wear (and none are seriously so) are separable from the gun, and can with great facility be renewed.

I am, &c.
(signed) *W. G. Armstrong.*

Elswick Engine Works,
Newcastle-upon-Tyne.

(B.)

Copy of Letter from Sir *W. Armstrong* to Captain *T. A. Blakely.*

8, Great George-street,
Westminster,
My dear Sir, 21 January 1857.

YOUR letter of the 19th has reached me here. At present I am making no guns, except for experimental purposes. If you have a valid patent for any method of construction which I may adopt, I shall, of course, on being satisfied of that, negotiate with you before I use it commercially. Until then the question may fairly stand over. You will observe that I make no claim to exclusive invention of anything, in my letter to the "Times," but have confined myself to a simple description of what I have done.

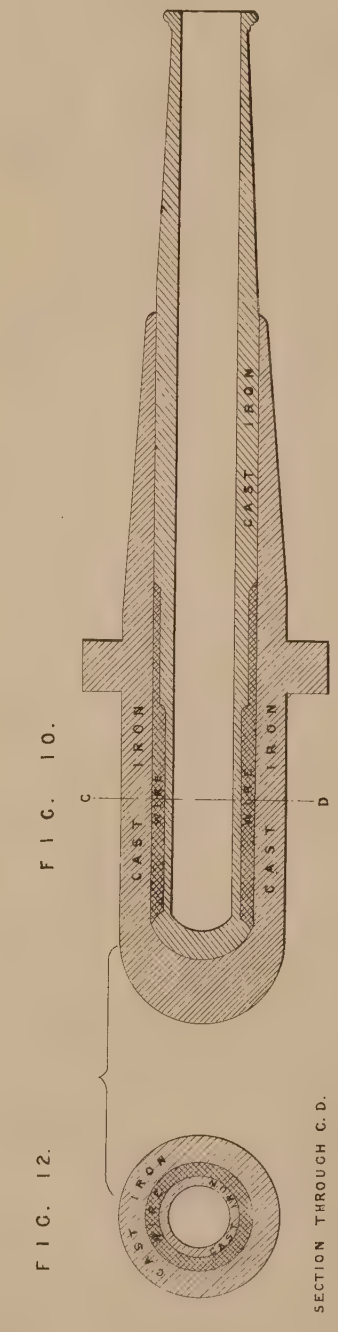
I am, &c.
(signed) *W. G. Armstrong.*

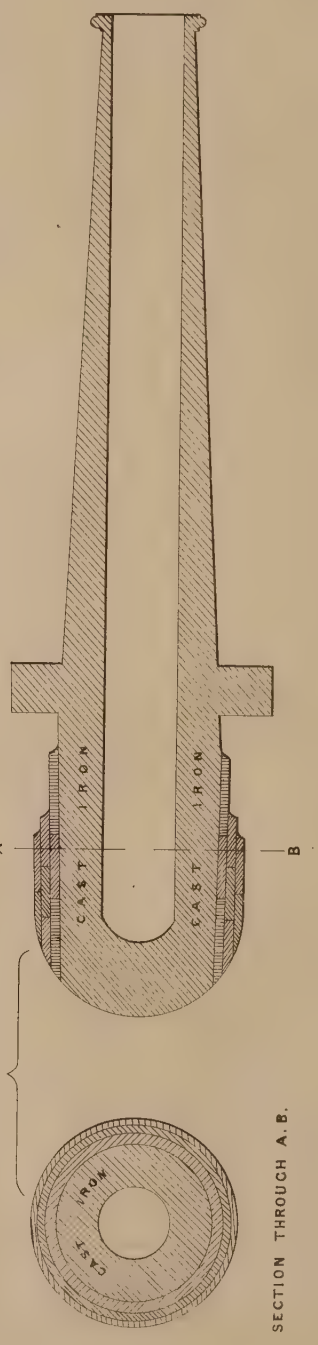
To Captain Blakely.

(C.)

The following is to be found at page 351 of the Minutes of Proceedings of the Royal Artillery Institution. It was communicated by Captain Younghusband, R.A., F.R.S., in April 1856:

"Mr. Armstrong was authorised by the Duke of Newcastle to construct one or more guns, not exceeding six in number, on the plan he had suggested in an interview with his Grace, and to make the necessary experiments in connexion with the subject, at the Government expense. Mr. Armstrong, acting upon this authority, has confined himself, up to the present time, in the production of a single gun; to make that one gun a test, not only of the principle he had recommended, but also of the feasibility of loading a field-piece at the breech; and likewise of applying certain mechanical arrangements to counteract recoil, and facilitate the laying and pointing. Careful consideration was first given to the tensile strength of the various materials suitable for the construction of a gun, and some experiments were made on the strength of cylinders of wrought iron, forged in the requisite form, and afterwards bored; the result of these experiments showed great uncertainty in the strength of the material, rendering it impossible to define the thickness necessary to resist a given charge of powder. Mr. Armstrong then decided upon, and ultimately completed a gun, of which the following is a description:—A core, or internal lining for the gun, was formed of cast steel, to which the requisite strength was given by encircling it with twisted cylinders of wrought-iron, made in a similar manner to gun barrels, and tightly contracted upon the steel core by the usual process of cooling after previous expansion by heat; the parts are then in that state of initial tension which is necessary to bring their entire strength into operation. Considerable difficulties were encountered in carrying this plan into practice. The arrangement for loading at the breech consists of a powerful screw having a hole through the centre in the prolonged line of the bore, through which hole the bullet and charge are delivered into the gun. A 'breech-piece,'





Nº 487.—Ordered, by the House of Commons, to be printed, 23 July 1863

Henry Hansard, Printer.

piece,' with a mitred face fitting a similar face at the end of the bore is dropped into a recess, and by the action of the screw pressed tightly into its seat, so as effectually to close the bore. The fitting surfaces which close the bore were at first made of unhardened steel—this failed; hardened steel was next used, but this yielded to the action of the powder more rapidly than before; copper was then tried, and no further difficulty was experienced. The breech-piece contains the vent. The bore of the gun which was made, is 1¾ inches in diameter, and contains eight spiral grooves, having an inclination of one turn in 12 feet; these grooves terminate at a distance of 14 inches from the breech, and the bore then gradually expands in a length of three inches, from 1¾ inches to 1⅞ths in diameter. The bullet, in the process of loading, passes freely through the widened space; but its diameter being a little in excess of the bore, it lodges in the tapered contraction of the commencement of the grooves. The weight of the gun by itself is about 5 cwt., including the carriage the weight is about 15 cwt., which is nearly identical with that of the light 6-pounder brass gun and carriage of the service. The weight of the projectile (composed of lead, hardened with antimony and tin), is three pounds. A long course of experiments was made to determine upon the best form of bullet; numerous forms were tried, and Mr. Armstrong was of opinion that experiments required to be still prolonged, in order to arrive at the greatest attainable perfection. The form last used was a cylinder pointed in front, with a conical end behind. The charge was 14 ounces of fine blasting powder. There is an ingenious arrangement by which the recoil is absorbed, and another by which the pointing and elevating is expeditiously and correctly performed. Mr. Armstrong considers that rifled guns of this construction will be especially valuable as guns of position, where a long range is required, and proposes them as adjuncts to, and not substitutes for, the present description of field ordnance. The objects he believes to have attained are strength, durability, long range, and accuracy. Respecting the construction of heavy ordnance by the process of twisting wrought-iron bars into cylinders, and combining them in the manner described, he believes no difficulty would be experienced if proper apparatus were provided for the purpose; but he does not recommend the breech-loading principle to be applied in such cases, because, in heavy ordnance, the moveable parts would be too cumbrous to be conveniently handled. The gun described above was brought to Woolwich to be inspected, and was then sent to Shoeburyness for experiment. Mr. Armstrong stated that 800 rounds had already been fired from it. At Shoeburyness 100 rounds were fired at elevations varying from ¼° to 7°. A very long range was obtained; though it was not always uniform, the direction was extremely accurate. The shot did not proceed point foremost after the first graze. All the shots that were recovered showed marks of their having completely taken the rifle grooves. A considerable escape of gas took place at the breech; the gun was loaded with great facility, and pointed quickly and accurately; the recoil was checked, but not entirely absorbed by the action of the slide on which the gun is mounted. After the completion of these experiments, Mr. Armstrong, believing the gun to be stronger than necessary, suggested its being returned to him to have it re-bored for a heavier projectile, and also to make some alteration in the rifling, by which he expected to obtain increased accuracy of fire. The gun was accordingly sent back to Newcastle."

Page 28, of "A few Remarks on the Science of Gunnery," 2d Edition, by Captain *Blakely* (*Ridgway*, Piccadilly).

THE method I propose for strengthening guns is, to replace the outside metal which is now nearly useless by metal put on so that when at rest it shall have already a tension upon it, and shall compress the interior, so that at the moment of firing the greatest possible proportion of the thickness of metal shall be nearly equally strained.

This can be effected in various ways, viz.:—By shrinking hot-iron rings on a cylinder of cast-iron, brass, or other material, and on them others, till the necessary strength is obtained; or the interior of the rings and exterior of the inside mass may be somewhat conical, and by forcing on the rings, the necessary degree of tension can be obtained; or, wrought-iron may be coiled, when at a white heat, round a centre of iron, steel, or brass, pressed by suitable means to its form, and allowed to cool; or, iron, or steel wire, flat or round, may be wound round an interior; or iron or other metal may be cast on an interior, slightly heated, so as not to give too great a tension to the outer layers, or of such a shape as to allow the outer part in cooling to get the right degree of tension.

Page 18 of "A cheap and simple Method of manufacturing strong Cannon," by Captain *Blakely* (*Ridgway*).

FIGURES 10 and 12 show a horizontal and a transverse section of a wire-strengthened gun. One made with these proportions could bear any strain gunpowder could directly cause. I can therefore see no reason why a solid shot weighing a ton should not be thrown eight miles from such a gun.

Figures 11 and 13 are a longitudinal and transverse section of a gun formed principally of cast iron, and reinforced near the breech with three layers of tubes forced on. I should prefer wrought iron for the latter. These guns may seem stronger than necessary near the breech, but it must be borne in mind, that it is only there that the largest guns are more strained than the smallest.

In various other obvious ways my object can be effected. This object is—so to construct guns that, at the moment of firing, the greatest possible proportion of the thickness of metal shall be nearly equally strained.

43, Chancery Lane, W.C.,
29 April 1859.

Gentlemen,

OUR client, Captain Theophilus Alexander Blakely, R.A., having ascertained that you are infringing his patent for improvements in ordnance, dated 27 February 1855, has instructed us to write to you to require that you immediately cease committing such infringements, and that you forthwith furnish to us, on his behalf, an account of all articles manufactured by you in violation of his rights under his said patent.

And we beg to inform you that, in the event of your not at once discontinuing such infringements,

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ments, or of your not forthwith furnishing to us, on behalf of the said Theophilus Alexander Blakely, the particulars we have asked for, he will cause such proceedings to be taken against you as he may be advised.

We are, &c.
(signed) *Cunliffe & Beaumont.*

To the Elswick Iron Company,
Newcastle-on-Tyne.

War Office
Gentlemen, 3 May 1859.

Your letter of the 29th ultimo, written on behalf of Captain Blakely, addressed to the Elswick Iron Company, has been forwarded to this Department, and I am directed by Secretary Major-general Peel to apprise you that this company is working out, under the officers of this department, a patent belonging to Her Majesty's Principal Secretary of State for the War Department, in respect of which no complete specification has yet been enrolled. I am directed to observe that Captain Blakely now is, and for some time past has been, in communication with the Secretary of State, in respect of an alleged infringement of his patent rights; and perhaps you will obtain from him his election either to continue those communications in the same spirit in which he has opened them, or to act through you as his legal agents; for it is scarcely necessary to observe that the Secretary of State cannot communicate with both Captain Blakely and his solicitors.

I have, &c.
(signed) *Chas. M. Clode.*

Messrs. Cunliffe & Beaumont.

(80—B—101.)

Army and Navy Club,
Sir, London, 7 July 1859.

Her Majesty's Government having erected workshops at Woolwich for the manufacture of Armstrong's guns, whose strength and efficiency are dependent on a system of construction invented and patented by me, I wrote to the late Secretary of State for War, requesting that he would cause to be paid to me the usual royalty. At the same time I directed a solicitor to commence proceedings against the Elswick Company, which is infringing my patent.

I have now before me a letter from Mr. Clode, solicitor of the War Department, to my solicitors, dated 3d May, informing him that the Secretary of State will not communicate with me about the infringement of my patent, at Woolwich, unless I cease legal proceedings against the Elswick Company for the infringement at Newcastle, as this company is working for the Government.

I feel extremely happy that Her Majesty's Government has thus accepted the responsibility of the proceedings of the Elswick Company in this matter, and deprived me of all legal redress, because I now feel the utmost confidence that the case will be judged by you, sir, on the principles of simple justice, and that you will see by the documents which will be brought before you—firstly, that accuracy of workmanship is useless for rifled cannon without great strength, as has been proved by the bursting of Mr. Whitworth's guns; secondly, that the method used by Sir William Armstrong for obtaining sufficient strength was invented by me, proposed to the Government in 1854, and again in 1855, when the Ordnance Select Committee declared it impracticable, and the calculations on which it is founded inapplicable to guns.

Thirdly, that in consequence of this Committee denying the truth of the theory I submitted to it, I have spent upwards of 1,200 *l.* in experimentally demonstrating its correctness, and in urging the adoption of my plans; fourthly, that in 1855, Lord Palmerston allowed Mr. R. Mallet to expend several thousands to test the truth of the same theory, which had been also discovered by that gentleman, the Ordnance Select Committee opposing the grant on the ground that the theory was wrong, thus acknowledging, at all events, the novelty of it.

I take the liberty of enclosing the copy of a paper I read lately to the U. S. Institution, which shows the number of experiments I have made at my own expense.

I trust I shall not be thought importunate if I beg for an early decision, as I have already been for some time awaiting it, and have now been obliged to give up a lucrative and interesting employment in Italy, for the purpose of returning to England to ask you for justice.

I have, &c.
(signed) *T. A. Blakely,*
Captain, Royal Artillery.

To the Right Honourable
the Secretary of State for War,
&c. &c. &c.

(80—B—101.)

War Office,
Sir, 11 August 1859.

I am directed by Mr. Secretary Herbert to acknowledge the receipt of your letter of the 7th ultimo, and to apprise you that he is advised that the patent of Sir William Armstrong does not in any degree infringe on your patent rights, and that, therefore, he is not prepared to admit that you have any claim for compensation in respect of any alleged infringements of your patent, by the construction of ordnance by this department, which is carried on under the patent of Sir William Armstrong, and under his directions.

I am, &c.
(signed) *B. Hawes.*

Captain Blakely, R.A.

(80—B—114.)

Army and Navy Club,
Sir, 25 August 1859.

In reference to your letter of the 11th instant, stating that you are advised that the guns now made by Sir William Armstrong for Her Majesty's Government are not so constructed as to infringe my patent, I have the honour to call your attention to the following words used by Captain Younghusband, R.A., F.R.S., in describing Sir William's first gun, and printed by the Royal Artillery Institution, at page 371 of its "Proceedings."

"A core, or internal lining for the gun, was formed of cast-steel, to which the requisite strength was

was given by encircling it with twisted cylinders of wrought-iron, made in a similar manner to gun-barrels, and tightly contracted upon the steel core by the usual process of cooling, after previous expansion by heat; the parts are then in that state of initial tension which is necessary to bring their entire strength into operation."

The Armstrong guns now being made must, I think, sir, be constructed either with this "initial tension, which is necessary to bring their entire strength into operation," or else without it. If with it, my patent rights can only be evaded by a legal quibble, of which you, sir, will never allow the department over which you preside to take advantage; if without it, the necessary strength can only be obtained by the use of more metal, or of a much more expensive metal, and put together in a much more expensive manner; and even so the size of guns so constructed must be very limited.

These being the only two possible alternatives, I take the liberty of begging you, sir, with the utmost deference, to make further inquiries as to the cost, in honour, in money, or in efficiency, at which my patent is evaded.

I have, &c.
(signed) *T. A. Blakely.*

To the Right Hon.
The Secretary of State for War,
&c. &c. &c.

War Office,
7 July 1863.

Alex. T. Tulloh,
Director of Ordnance.

Appendix, No. 70.

App. No. 70. MONTHLY and QUARTERLY DIARIES of OFFICERS commanding BATTERIES of 9-pounder ARMSTRONG GUNS since such were first issued to the ROYAL ARTILLERY.

Royal Horse Artillery Office,
Sir, Woolwich, 7 March 1862.

I HAVE the honour to forward the enclosed extracts from the Armstrong Gun Diaries of the batteries, Royal Horse Artillery, under my command, and request your attention to Colonel Phillpot's letter of 28th February, and also the extracts from the Diaries of A and B batteries relative to the tangent scales of the 9-pounder Armstrong guns.

I have, &c.
(signed) *H. G. Teesdale*, Colonel,
Commanding R.H.A.

The Deputy Adjutant General,
Royal Artillery, Horse Guards.

Sir, Woolwich, 1 March 1862.

I HAVE the honour to forward the following remarks from the "Armstrong Gun Diary" of this A battery, Royal Gun Factory.

21 February, 32 gun. Spring pin of breech both lost in the field; has been replaced by pin and tie.

The tangent scales appear to be fixed in a very insecure manner, and are liable to be lost in the event of the upsetting of a gun.

I have, &c.
(signed) *G. Le M. Tupper*,
Commanding R.H.A. Major.

Officer Commanding Royal
Horse Artillery.

Sir, Woolwich, 28 February 1862.

I HAVE the honour to inform you that the only observations I have to make on the 9-pounder Armstrong battery under my command, for the present month, are that the vent-pieces will not fit into the leather pockets; the tangent scales being loose in the socket, I should think would be liable to jump out in rough ground.

I have, &c.
(signed) *L. G. Paget*, Captain R.H.A.,
Commanding B Battery, H.B.R.A.

Colonel Commanding Royal
Horse Artillery.

Sir, Woolwich, 1 March 1862.

I HAVE the honour to inform you that I have nothing to report during the past month on the Armstrong battery under my command.

I have, &c.
(signed) *W. G. Andrews*,
Brevet Major, R.H.A.,
Commanding D Battery, R.H.A.

The Officer Commanding
Royal Horse Artillery, Woolwich.

Portobello Barracks, Dublin,
28 February 1862.

Abstract from Diary of Armstrong Guns,
G Battery, Royal Horse Artillery.

RECEIVED new equipment of 9-pounder Armstrong guns, 20th February 1862.

27 February 1862. A keep pin of lever broken, No. 9 gun; replaced same day by armourer serjeant.

(signed) *H. P. Newton*, Brevet Major,
and Captain R.H.A.

The Officer Commanding
Royal Horse Artillery, Woolwich.

Sir, Woolwich, 28 February 1862.

I HAVE the honour to inform you, that I have nothing to report with reference to the Armstrong guns of the battery under my command during the month of February 1862.

I have, &c.
(signed) *E. Michell*, Lieut.-Colonel,
Commanding H Battery, R.H.A.

The Officer Commanding
Royal Horse Artillery, Woolwich.

DIARY of the Armstrong Guns of Captain *W. B. Saunders*, I Battery, Royal Horse Artillery. For the month of February 1862.

Aldershot, 28 February 1862.

1st. Guns not used.
2d. Sunday.
3d. Guns not used.
4th. Field manœuvres under Lieut.-General J. L. Pennefather.
5th. Guns not used.
6th. - - ditto.

7th. Gun

7th. Gun drill under the commanding officer.
8th. Guns not used.
9th. Sunday.
10th. Guns not used.
11th. - - ditto.
12th. - - ditto.
13th. Gun drill under the commanding officer.
14th. Guns not used.
15th. - - ditto.
16th. Sunday.
17th. Guns not used.
18th. - - ditto.
19th. - - ditto.
20th. - - ditto.
21st. Gun drill under the commanding officer.
22d. Guns not used.
23d. Sunday.
24th. Guns not used.
25th. Field manœuvres under Lieut.-General Sir J. L. Pennefather.
26th. Guns not used.
27th. - - ditto.
28th. - - ditto.

(signed) *W. A. F. Strangways*,
Captain R. H. A.

The Officer Commanding
Horse Brigade, Royal Artillery, Woolwich.

Dublin, 27 February 1862.

Copy of entries in the Armstrong Gun Diary of K Battery for the month of February 1862.

20 February. 12-pounder guns given into store, and 9-pounder guns received.

(True copy.)

C. G. Arbuthnot, Brevet Major R.H.A.
Commanding K Battery.
A. Phillpotts, Colonel R. H. A.

The Commanding Officer
Horse Brigade, Royal Artillery, Woolwich.

Royal Horse Artillery Office,
Dublin, 28 February 1862.

Forwarded to the Officer Commanding Royal Horse Artillery, Woolwich.

A. Phillpotts, Colonel, R.H.A.

Royal Horse Artillery Office, Woolwich, 15 April 1862.

Sir,

I HAVE the honour to forward the enclosed extracts from the Armstrong diaries of brigade under my command, and beg to draw your attention to that of G battery reporting a flaw in No 3, 9-pounder gun.

I have, &c.
(signed) *D. E. Wood*, Colonel
Commanding R. H.

The Deputy Adjutant General,
Royal Artillery, Horse Guards.

Woolwich, 1 April 1862.

Sir,

App. No. 70.

I HAVE the honour to inform you that nothing is recorded in the "Armstrong Gun Diary" of this A battery during the month of March.

I have, &c.
(signed) *G. Le M. Tupper*,
Commanding R. H. A., Major.

To the Officer Commanding
Royal Horse Artillery.

Woolwich, 9 April 1862.

Sir,

I HAVE the honour to state, that I have no observations to make on the 9-pounder Armstrong equipment of the battery under my command for the month of March, except that I still am of opinion that it would be very desirable to have a brass plate affixed to the trail, with the range, elevations, and deflexions marked upon it.

I have, &c.
(signed) *L. G. Paget*, Capt. R. H. A.,
Commanding B Battery H. B. R. A.

Colonel Sir David Wood, K.C.B.,
Royal Horse Artillery.

Woolwich, 1 April 1862.

Sir,

I HAVE the honour to inform you that I have nothing to report during the past month on the Armstrong battery under my command.

I have, &c.
(signed) *W. Johnson*, Capt.
Commanding D Battery R. H. A.

The Officer Commanding Royal
Horse Artillery, Woolwich.

Portobello Barracks, Dublin,
1 April 1862.

Abstract from Diary of Armstrong Guns G Battery, Royal Horse Artillery.

ON the 3d March a flaw was discovered in No. 3 gun, about two feet from the muzzle, and on the upper left hand side of the bore. An impression was taken of it in gutta percha by the armourer serjeant.

(signed) *H. P. Newton*, Brevet Major
and Capt. R. H. A.

The Officer Commanding
Royal Horse Artillery, Woolwich.

Royal Horse Artillery Office,
Dublin, 1 April 1862.

Forwarded to the Officer Commanding Royal Horse Artillery, Woolwich.

A. Phillpotts, Col. R.H.A.

App. No. 70.

Sir, Woolwich, 1 April 1862.

I HAVE the honour to report that there has been one entry (purport as per margin*) in the Armstrong Gun Diary of H battery under my command during the past month.

I have, &c.
(signed) *E. Michell*, Lieut.-Col.
Commanding H Battery, R. H. A.

The Officer Commanding
Royal Horse Artillery, Woolwich.

Camp, Aldershot,
Sir, 31 March 1862.

I HAVE the honour to report that during the past month no casualty has occurred in the battery of Armstrong guns under my command; and there are no entries in the diary.

I have, &c.
(signed) *W. B. Saunders*, Capt. R. H. A.,
Commanding T Battery.

The Officer Commanding Horse Brigade,
Royal Artillery, Aldershot.

Royal Horse Artillery Office,
Sir, Woolwich, 10 April 1862.

I HAVE the honour to request that the extract from the Armstrong Diary of the battery under your command, due on 1st instant, and not yet received, may be forwarded as early as possible.

I have, &c.
(signed) *E. Markham*,
Capt. and Adj. R. H. A.

The Officer Commanding K Battery,
Royal Horse Artillery, Dublin.

Forwarded to the Officer Commanding Royal Horse Artillery, Dublin, as a report was sent to him on the 31st ult., stating that there were no entries in the Armstrong Diary of K battery for the month of March 1862.

(signed) *C. G. Arbuthnot*,
11 April 1862. Brevet Major, R. H. A.

Royal Horse Artillery Office,
Dublin, 12 April 1862.

A report was received in this office from K battery to the above effect, which report must have been mislaid, as the clerk states it was forwarded to Woolwich; I am under the impression it was mislaid in this office.

A. Philpotts, Col. R. H. A.

Sir, Woolwich, 14 July 1862.

THERE are many particulars mentioned in the accompanying reports of the officers commanding Armstrong batteries of the Horse Brigade, for the present quarter, deserving attention; but I beg to bring more especially to your notice the three following subjects in connection therewith:—

1. The liability to upset of the 9-pounder 6 cwt. Armstrong gun, as at present mounted.
2. Gun rendered unserviceable, and damage likely to occur to breech screw, from dust or particles of gravel, lodging.
3. Complaint regarding wood employed for wheels, hand-spikes, &c.

With regard to the first, viz, the liability of the gun to upset, which I have myself remarked, and which is characterised as "liveliness" in C battery report, I imagine this can only be obviated by placing the gun lower on its carriage; and this, I submit, might be accomplished by substituting horns in place of the long lever handle to the breech screw.

The damage likely to occur to the breech screw from dust or particles of gravel lodging, is a very serious business; and, as appears in the report from B battery, a gun was the whole day unserviceable in consequence.

The wood employed generally in our equipment has already been often called in question, and so long as wood subject to the desiccating process is made use of, instead of well-seasoned timber, I apprehend there must be complaints.

Without entering into details on the various other points specified in these reports, I will only add that all the reports are deserving serious perusal and consideration.

I have, &c.
(signed) *Charles D'Aguilar*,
Colonel, R. H. A.

Colonel Sir David Wood, K.C.B.,
Commanding R. H. A.

The reports herewith enclosed, and the report of Colonel D'Aguilar, C.B., are forwarded for the serious consideration of the proper authorities.

(signed) *D. Wood*, Col. Commanding,
1st Horse Brigade, R. A.

Sir, Aldershot, 30 June 1862.

WITH reference to the Armstrong gun equipments furnished to this A battery, Royal Horse Artillery, I have the honour to report as follows:—

Class 2. Plug lost out of water bucket in field, owing to breaking of chain.

Hinge of fuze-box of one of the ammunition waggons broke off.

Class 4. Number of miles travelled in May, 97; rounds blank fired, 202. Number of miles travelled in June, 58; rounds blank fired, 160.

I have, &c.
(signed) *G. Le M. Tupper*,
Capt., R. H. A., and Major.

Colonel Honourable G. Devereux,
Royal Horse Artillery.

Forwarded.

(signed) *G. Devereux*, Col., R. H. A.

1 July 1862.

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* Reporting, to officer commanding, the unserviceable state of a fuze box.

Sir, Aldershot, 1 July 1862.

In forwarding my June quarterly report of the Armstrong battery under my command, I have the honour to make the following remarks :—

Class 1. Defects of the guns or sights.

On the 2d May the breech screw of No. 26 gun got jammed in the gun by gravel getting into the slot, and working into the male screw, which rendered the gun unserviceable for the remainder of the day. Six worms of the screw found injured.

There are several openings in the welds of the guns. One just inside the muzzle of No. 26 gun would surely widen, if not carry away a portion of the muzzle, when fired with shot.

Class 2. Defects of the carriages special to Armstrong equipment : " Nothing to report."

Class 3. Defects of the carriages, having no particular reference to the Armstrong equipment.

The wheels of my battery are bad. The Serjeant Wheeler is of the same opinion. They are shrinking very much, and if the weather had been at all hot, the whole of the wheels would be in a very shaky condition. The spokes are apparently made of unseasoned wood. On the 15th June one spoke of a gun wheel was broken, and four other spokes so much started from the nave as to require new spokes. No reasonable cause for this injury. On the 30th June an off-shaft of a waggon accidentally broken, the shaft found with the dry rot. A handspike broken at drill found quite dusty with dry rot. This equipment only issued in February last. I have before given my opinion that the new gun covers are worse than useless. The guns had far better be exposed altogether. The tube pockets are faulty, as allowing the tubes to jump out. The men will not invariably remember to button down the lid after taking out a tube. The sides of the pockets should not be of stiff leather, the pocket ought to be more of a bag. I also observe that the four spare sponge cortings cannot be carried in the near axle-tree box, as laid down in the detail.

I observe no injury at present to the lead at the heel of the shells.

Class 4. Complaints peculiar to Armstrong ammunition and small stores.

The shell plugs work out very much. Those in my battery have string loops, and are of gun metal.

In conclusion, my battery during the months of May and June has fired 486 rounds of blank ammunition, and travelled about 134 miles.

I have, &c.

(signed) *L. G. Paget*, Capt., R. H. A.
Commanding B Battery, 1st H.B., R.A.

Colonel Honourable G. T. Devereux,
Royal Horse Artillery, Aldershot.

Forwarded.

The flaw mentioned, near the muzzle of No. 26 gun, is only such as is to be found in many others, and is of no importance.

(signed) *G. T. Devereux*, Col., R.H.A.
1 July 1862.

Sir, Woolwich, 1 July 1862.

With reference to the Armstrong Diary of the battery under my command, I have the honour to report as follows :—

Class 1. Defects of the guns or sights :—Nil.

Class 2. Defects of the carriages special to Armstrong equiqments :—Nil.

Class 3. Defects of the carriages, having no particular reference to the Armstrong equipments: —Nil.

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Class 4. Complaints peculiar to Armstrong ammunition and small stores :—Nil.

There has beeu 145 rounds blank ammunition fired per gun, and the guns have travelled about 170 miles during the past two months.

I have, &c.

(signed) *W. Johnson*, Capt.,
Commanding W Battery, R.H.A.

The Officer Commanding
Royal Horse Artillery, Woolwich.

E Battery, Royal Horse Artillery,
Sir, Woolwich, 1 July 1862.

With reference to the Armstrong Diary of the battery under my command, I have the honour to report as follows :—

Class 1. Defects of the guns or sights :—Nil.

Class 2. Defects of the carriages (Armstrong): —Nil.

Class 3. Defects of the other carriages :—Nil.

Class 4. Complaints peculiar to Armstrong ammunition and small stores :—Nil.

There have been 50 rounds of blank ammunition fired per gun, and the guns have travelled about 100 miles during the past 2½ months.

I have, &c.

(signed) *A. M. Calvert*, Capt.,
Commanding E Battery, R. H. A.

Camp, Curragh, 1 July 1862.

Quarterly Report of Armstrong Guns of G Battery, 1st Horse Brigade, Royal Artillery.

Class 1. Nothing to report.

Class 2. Nothing to report.

Class 3. Nothing to report.

Class 4. Nothing to report.

Number of Gun.	Number of Rounds fired during the Quarter ending 30 June 1862.			Number of Miles travelled during the Quarter.
	Blank.	Service.		
9	37	- nil -		250
4	37	- nil -		250
6	37	- nil -		250
3	37	- nil -		250
8	37	- nil -		250
5	36	- nil -		250

(signed) *Francis Lyon*, Captain,
for the Officer Commanding
G Battery, R.H.A.

To the Officer Commanding
Royal Horse Artillery, Woolwich.

Royal Horse Artillery Office,
Dublin, 5 July 1862.

Forwarded to the Officer Commanding Royal Horse Artillery, Woolwich.

F. G. Baylay, Captain,
Royal Horse Artillery, for Colonel Commanding, absent on leave.

App. No. 70.

Sir, Woolwich, 1 July 1862.

I HAVE the honour to transmit my report of the Armstrong equipment of the battery under my command, for the quarter ending 30th June 1862.

Class 1. Guns and sights.—Nothing to report.

Class 2. Defects of carriages special to Armstrong's equipments.—Nothing to report.

Class 3. Defects of carriages, no special reference, &c.—The new axle-tree box is too small to contain the articles supposed to be carried in it; there is room on the axle-tree bed for a larger box.

The edges of the platforms on which the limber boxes rest seem exposed, and from their shapes are liable to injury from the trail plate eye, in limbering up.

The small chambers in the limber boxes for the shells are, from their interior roughness and sharp edges, and also by the heads of some of the screws, which are exposed, liable to damage the lead coating of the shells. This has already taken place to a slight extent.

These defects are being remedied, as far as possible, by the battery artificers; but it is suggested that their sides should be lined with serge, as are their bottoms; or that a small quantity of tow should be allowed for the purpose of packing the shells more securely.

Class 4. Ammunition.—The bottoms of the shells do not as yet show any signs of enlargement, but there are no gauges as yet received.

I have further to report that the guns have travelled about 154 miles since the last report, and have fired 180 rounds of blank ammunition.

I have, &c.
(signed) *Edward Michell*,
Captain, R. H. A., and Lieut.-Col.

The Officer Commanding Royal Horse Artillery.

Quarter ending 30th June 1862.

Camp, Aldershot, 1 July 1862.

Report founded on Entries in Diary of Armstrong guns kept in I Battery, Horse Brigade, Royal Artillery.

Class 1. Defects in guns or sights.—The trunnion sights of all the guns, without exception, are loose in their sockets; so much so, as in most cases would interfere materially with the accuracy of the firing.

Class 2. Defects of carriages special to Armstrong equipments.—The limber gunners complain of the weight of the trail when first lifted from the ground in limbering up. Would it not be possible to shift the centre of gravity of the gun rather further back?

Class 3. Defects in carriages not having any particular reference to Armstrong equipments.—A wheel accidentally broken in going over rough ground, showed, from the short way in which the felloe was fractured, that the substance of the wood was quite destroyed, probably by the desiccating process.

Class 4. Complaints peculiar to Armstrong ammunition and small stores.—Having carefully examined the whole of the shells carried point uppermost, I am unable to detect any enlargement at the base of any of the shells. The gauges have not yet been supplied. The guns have travelled during the last two months about 145 miles, at exercise, &c., and about 80 rounds per gun of blank ammunition have been fired during the same period.

(signed) *W. B. Saunders*,
Captain, R. H. A.

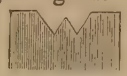
Forwarded.

(signed) *G. T. Devereux*,
Colonel, R. H. A.

3 July 1862.

Report on Armstrong Guns and Carriages of K Battery, 1st Horse Brigade, Royal Artillery.

Dublin, 1 July 1862.

Class 1. Defects of guns and sights.—The new pattern tangent and trunnion sights for the nine-pounder guns do not fit properly in the sockets. There is sufficient play to cause considerable error in laying the guns. The guards of the trunnion sights  are higher than the point; this is a great defect, but has, I am informed, been remedied in sights recently issued.

The shape of the tangent sight is, in my opinion, defective. The head ought to be square, or, rather, at such an angle as to bring the upper edge level.

I have, at the suggestion of Lieutenant Parsons, tried a square-headed tangent sight and a trunnion sight, without guards, and found them a great improvement.

There are no defects in the guns. The same quickness of fire and accuracy of aim cannot be obtained without the traversing beds, and I think their adoption would be a great improvement: without them, the good qualities of the gun are neutralised.

Class 2. Defects of carriages special to Armstrong equipments.—None.

Class 3. Defects of the carriages, having no particular reference to the Armstrong equipment.—The rear foot-boards of the waggon bodies are too narrow. They are only $6\frac{3}{4}$ inches; ought to be one foot.

The perches are one inch too short; the limber wheels lock against the spare wheel.

Class 4. Complaints peculiar to Armstrong ammunition and small stores.—None.

Number of rounds of service ammunition fired per gun, 30.

Of blank cartridge, 16.

Number of miles travelled by gun carriages in the months of May and June, about 140.

(signed) *C. G. Arbuthnot*,
Brevet Major, R. H. A., Commanding K Battery.

The Commanding Officer Royal Horse Artillery, Dublin.

Royal Horse Artillery Office, Dublin, 2 March 1862.

Forwarded to the Officer commanding Royal Horse Artillery, Woolwich.

(signed) *A. Phillpotts*,
Colonel, R. H. A.

Sir, Newbridge, 30 June 1862.

I HAVE the honour to report as follows on the Armstrong nine-pounder equipment, lately received by C. Hatley, Royal Horse Artillery.

1. The guns, carriages, &c., are all perfectly serviceable.

2. The guns, and all parts belonging thereto, were found quite correct on being received, with the exception of the lever of the breech screw of No. 58 gun, which, it was found, would not fit any of the breech screws in the battery, being too small; it did not appear to have been bent or injured in any way. Directions were therefore given to have the ring filed all round, and thus it was made large enough for the breech screw of No. 58 gun; it having originally come in a box along with the other fittings for that gun.

3. The yellow metal plugs very frequently work out of the shells. I have given directions to have some carried upside down, to ascertain how they will travel when thus carried.

4. At a divisional field day (25th June 1862), one of the guns, No. 52, was completely upset, both horses (wheel), limbers, and gun being upside down; no part of the gun, its sights or carriage, was injured in the slightest. The gun was the flank gun of the battery, which was taking up a position at a gallop, over some undulating ground, which formed the end of a spur of a hill. I did not consider it ground where horse artillery could move with rapidity; however, facts proved otherwise, and I have since observed that those guns appear to be far more "lively" on rough ground than the old six-pounder. I attribute this "extra liveliness" to the circumstance of the weight of the gun being so much higher (from four to five inches) than in the six-pounder. I conceive that it is a great defect in a horse artillery gun, and would suggest that the gun be lowered on its carriage, so as to counteract the "lively" tendency as much as possible; great range being but a secondary consideration for horse artillery.

I have, &c.
(signed) *H. J. Hay*, Major, R. H. A.

The concussion fuzes have not yet been received, nor the powder.

(signed) *H. J. H.*

Number of Rounds of Blank and Service fired during the Quarter ending 30th June 1862.

	Blank.	Service.
	—	—
R. G. F., No. 52 -	40	0
„ No. 57 -	40	0
„ No. 58 -	40	0
„ No. 59 -	40	0
„ No. 60 -	40	0
„ No. 61 -	40	0

Distance travelled by each gun, about 260 miles.

(signed) *H. J. Hay*, Major, R. H. A.

Colonel A. T. Phillpotts, &c.,
Royal Horse Artillery, Dublin.

App. No. 70.

Royal Horse Artillery Office, Dublin, 1 July 1862.

Forwarded to the Officer Commanding Royal Horse Artillery, Woolwich.

(signed) *A. Phillpotts*, Colonel, R. H. A.

Royal Horse Artillery Office, Woolwich, 25 July 1862.

Forwarded to the Officer commanding Royal Horse Artillery in Ireland, who is requested to call upon the Officer commanding C battery, to complete this report, agreeably to Deputy Adjutant General's Minute of 24th instant.

By order,

(signed) *D. Markham*,
Captain and Adjutant.

Royal Horse Artillery Office, Dublin, 26 July 1862.

Returned to the Officer Commanding C battery, Royal Horse Artillery, for completion.

(signed) *A. Phillpotts*, Colonel, R. H. A.

Sir, Woolwich, 14 July 1862.

I HAVE the honour to report, that in the equipment of the Armstrong battery, issued to the F battery, Royal Horse Artillery, the following defects have been discovered.

Class, No. 1. Five of the trunnion sights and five tangent scales have not been properly adjusted.

Class, No. 2. No defects.

Class, No. 3. The locks of five of the ammunition boxes do not work.

Class, No. 4. No defects.

Number of rounds fired per gun.—Nil.

Number of miles travelled unknown; but calculated as 40 miles.

I have, &c.
(signed) *David Fraser*,
Capt. R. H. A., Lieut. Col. Commanding F Battery, Royal Horse Artillery.

The Officer Commanding Horse Brigade, Royal Artillery, Woolwich.

Sir, Dublin, 30 Sept. 1862.

I HAVE the honour to forward the following report on the Armstrong guns of this A battery.

Class 1. Spring keep-pin of elevating eye bolt lost in the field.

Class 3. Several of the wooden linings to the fuze boxes have split or become otherwise damaged by the jolting of the carriages.

Class 4. Several shell plugs have also worked out; these are of copper, and without loops.

Some shells were also found to have jolted out of their compartments in the waggon body at a field day.

App. No. 70.

The Table below shows the number of miles travelled (approximate), and rounds fired during the past quarter.

Miles Travelled.	Rounds blank Fired.	Rounds Service Fired.	Royal Gun Factory.
89	555	- -	July.
102	592	- -	August.
173	- -	208	September.
364	1,147	208	- - Total.

I have, &c.
(signed) *G. Le M. Tupper,*
Commanding R. H. A., and Lt. Col.

Col. Phillpotts, Commanding
Royal Horse Artillery, Dublin.

Dorchester Barracks,
Sir, 30 September 1862.

In forwarding my September quarterly report of the Armstrong battery under my command, I have the honour to make the following remarks:—

Class 1. Defects of the guns or sights: "Nothing to add to my last quarterly report."

Class 2. Defects of the carriages special to Armstrong equipments: "Nothing to report."

Class 3. The wheels of my battery are bad. The grease does not appear to work through the shoulders of the wheels in all instances; the arms thus get covered with the black dust peculiar to Aldershot, and are worn by the friction; the arms are greased and cleaned daily. Box of near limber wheel of No. 27 gun much worn. The axletree bed of No. 24 gun much cracked, and box of off limber wheel unserviceable from friction; the face of the box of the wheel of No. 23 gun, a good deal chipped. The box of the off limber wheel of No. 22 gun, unserviceable from friction. The box of the near gun wheel of No. 29 gun, unserviceable from friction; this wheel had to be changed on the line of march. The trails of the guns are cracking very much. The trail of No. 27 gun I consider unserviceable. The paint used for the carriages appears very bad; the carriages of my battery are not fit to be seen; they require painting at once; deep cracks and fissures are seen in all directions.

I observe no injury to the lead at the heel of the shells.

Class 4. "Complaints peculiar to Armstrong ammunition and small stores."

The shell plugs have strong loops, and are of gun metal.

I have omitted to mention, under Class 1, that I consider the idea of the tangent sights being insecure as quite fallacious; I have had a gun upset, but the tangent scale did not come out.

The battery, during the quarter, has travelled about 304 miles, and has fired 1,490 rounds of blank ammunition.

I have, &c.
L. G. Paget, Capt. H. A.,
Com. B Battery, 1st H. B. R. A.

Col. Sir David Wood, K.C.B.,
Commanding Royal Horse
Artillery.

Horse Guards, 5 Nov. 1862.

Returned, that the guns may be properly described, by showing whether they are of Royal Gun Factory or Elswick Ordnance Company manufacture.

Andrew Bingham, D. A. G.

Answer. Gun Factory.
D. Wood.

Sir, Aldershot, 6 October 1862.

I have the honour to report regarding the equipment of my battery, as follows:—

1. That the guns appear to have much play between the trunnion holes of the carriages.

2. The hook of the lever appears to be of most use when on the horn of the elevating screw.

3. The new linings for the fuze boxes would be more convenient if made to hold time and concussion fuzes.

4. The sights appear to be sufficiently simple and accurate for horse artillery guns.

The drill shot are of too high gauge, and from the want of lead towards the point, injure the copper ring.

Number of rounds of blank and service fired during the quarter ending 30th September 1862.

	Blank.	Service.
R. G. F. - No. 52	297	nil.
" - No. 57	297	nil.
" - No. 58	297	nil.
" - No. 59	297	nil.
" - No. 60	297	nil.
" - No. 61	297	nil.
	1,782	

Distance travelled about 480 miles.

I have, &c.
(signed) *H. J. Hay,*
Major Royal Horse Artillery,
Commanding C Battery.

Col. the Hon. G. T. Devereux,
Royal Horse Artillery, &c.,
Aldershot.

Forwarded to the Officer Commanding Royal Horse Artillery.

(signed) *G. T. Devereux,*
Colonel, Royal Horse Artillery.
6 Oct. 1862.

Sir, Woolwich, 1 October 1862.

With reference to the Armstrong Diary of one battery under my command, I have the honour to report as follows:—

Class 1. Defects of the guns and sights:—Nil.

Class 2. Defects of the carriages special to Armstrong equipments:—Nil.

Class 3. Defects of the carriages having no particular reference to the Armstrong equipments:—Nil.

Class 4. Complaints peculiar to Armstrong ammunition and small stores:—Nil.

During

During the past quarter there have been 150 rounds of blank ammunition fired per gun, and they have been travelled about 200 miles.

I have, &c.
(signed) *Ralph Hare*, R. H. A.
Commanding D Battery, Royal Horse Artillery.

The Officer Commanding
Royal Horse Artillery,
Woolwich.

Sir, Woolwich, 19 November 1862.

I HAVE the honour to transmit an amended report of the Armstrong guns attached to the battery under my command.

Class 1. With regard to the sights, great difficulty was experienced by the men in laying the gun during practice at Shoeburyness, owing to the great breadth of the notch in the trunnion sight. This was reported by the commandant of the school of gunnery. Several small flaws were noticed in the guns, said to be openings in the weld. I do not think they have enlarged by firing. The guns have fired 75 rounds blank ammunition, 52 shot, and 324 shells during the past quarter. They have travelled 120 miles.

Class 2. Nothing to report.

Class 3. Nothing to report.

Class 4. Nothing to report.

I have, &c.
(signed) *R. H. Newbolt*, Capt., R.H.A.
Commanding E Battery, R.H.A.

The Officer Commanding Royal
Horse Artillery, Woolwich.

F Battery, 1st Horse Brigade, Royal Artillery.
Report on Armstrong Equipment for the quarter ending 30 September 1862.

Woolwich, 1 October 1860.

Class.	Defects.
1	Nil.
2	Nil.
3	Hinges of limber-boxes appear to be badly welded in the joint; two have broken, and cannot be repaired by the farrier. No Armourer Serjeant has yet been appointed to the battery.
4	Nil.
Ammunition service.	Guns No. 2 and 68 fired per gun, 83 rounds of shot. 15 „ of shell. Guns No. 65 and 69 fired per gun, 81 rounds of shot.
Ammunition blank.	80 rounds per gun.
Travelled -	198 miles.

N.B.—These guns are all of Royal Gun Factory manufacture.

I have, &c.
(signed) *David Fraser*, Capt., R.H.A.
Lieut.-Col., Comg. F Battery, R.H.A.
E. Price, Col. R. H. A.

The Officer Commanding 1st Horse
Brigade, Royal Horse Artillery.

0.39.

Horse Guards, 5 November 1862. App. No. 70.

RETURNED, that the guns may be properly described, by showing whether they are of Royal Gun Factory or Elswick Ordnance Company manufacture.

Andrew Bingham, Dep. Adj. Gen.

F Battery. Information given in a note on front of report.

David Fraser, Capt. R.H.A.,
Lieut.-Col. Comg. F Battery.

Quarterly Report of Armstrong Guns of G Battery, 1st Horse Brigade, Royal Artillery.

Aldershot, 1 October 1862.

Class 1. After having carried on practice with these guns, I am very strongly of opinion that it would be much better if the guards of the trunnion sight should be of the same height as the sight itself, by which means the required elevation is much more easily and rapidly obtained.

The cross sight, as used with the first Armstrong guns, is a very great improvement, and far preferable to that now with the 9-pounders.* It is nearly impossible to lay a gun incorrectly with it; it is very easily and quickly used, and the want of it was very much felt during the practice. It would be of very great advantage if the distances were marked on the tangent and deflexion scales, instead of the degrees. It is already done on the ratchet sight, and on all infantry rifles, and in other services. A ratchet sight would be of much use for horse artillery, when very quick firing is so much oftener required.

Class 2. In quick firing, the want of a traversing bar† was very palpable, and very accurate; shooting on soft ground cannot be insured without it. The extra weight would be fully compensated for by the advantages gained by it.

Class 3. Nothing to report.

Class 4. Nothing to report.

(signed) *H. P. Newton*, Capt. and
Brevet Major, R.H.A.

Number of Gun.	Number of Rounds Fired during the Quarter ending 30 September 1862.		Number of Miles Travelled during the Quarter.
	Blank.	Service (Practice.)	
9 R. G. F -	176	50	405
4 R. G. F -	176	50	405
6 R. G. F -	177	50	405
3 R. G. F -	177	50	405
8 R. G. F -	177	50	405
5 R. G. F -	177	50	405
	920	300	

(signed) *Francis Lyon*, Capt.
Comg. G. Battery, R. H. A.

To the Officer Commanding Royal
Horse Artillery, Woolwich.

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* I do not agree with this; the difficulty in laying the gun with the present sight is caused by the notch being too deep. *G. T. Devereux*, Colonel.
I agree in the remark of Colonel Devereux.

† I do not think a traversing bar applicable to the Horse Artillery. *D. Wood*, Colonel.

App. No. 70.

Forwarded to the Officer Commanding Royal Horse Artillery.

(signed) *G. T. Devereux*,
1 October 1862. Col. R.H.A.

Royal Horse Artillery Office,
Woolwich, 10 Nov. 1862.

Forwarded to the Officer Commanding Royal Horse Artillery, Aldershot, who is requested to call upon the Officer Commanding G battery to furnish the information required.

By order,
(signed) *A. H. King*,
Capt. R.H.A.

Guns, Royal Gun Factory.

Sir, Woolwich, 6 Oct. 1862.

I HAVE the honour to transmit my report on the Armstrong equipment attached to the battery under command.

Class 1. Guns and sights:—Adverting to the memorandum from Adjutant General's Office, dated 30th August 1862, I beg to state that my attention was attracted to the sights therein alluded to, and their apparent insecurity; and upon receiving a similar explanation to that now given I refrained from mentioning them in my last report.

As to their security, I may state that more of them have shaken out since I have had them.

In one instance, a gun was upset, and turned completely over; the sight then came half out, but catching the ground, was bent and rendered unserviceable.

The guns of the battery have not been over any rough ground, and the scales may become loosened by wear. Now, while they are pretty tight, they require some care on the part of him who lays the gun that the collar be well down on the socket in the gun, or he will give more elevation than he intends.

Class 2. Defects of carriages special to Armstrong equipments:—The wooden frames which hold the fuzes being heavy, and having too much play in the tin boxes or trays, seem liable, and in some instances have already injured the trays, bulging out their sides, and opening their joints.

Class 3. Carriage: no special reference to this equipment:—Nothing to report.

Class 4. Ammunition:—Some wooden frames have been received, evidently for the concussion fuzes; but in order to use them it would be necessary to take them out of those waterproof cases in which they are now so carefully and safely packed, and which it seems almost a pity to do. These frames for carrying the fuzes open would be most useful on active service, as much time would be saved in not having to open the tins; but now they seem better as they are; to carry a double set of frames materially increases the bulk of the stores, and they would be liable to be injured in travelling.

Reverting to the Class 1, the guns themselves, I beg to report that there are a great many flaws in the bores, of various extent. I have caused my armourer serjeant to make an examination of the bores of the guns, and I beg to attach his report.

I have, &c.
(signed) *Edward Michell*,
Capt. R.H.A., and Lieut.-Col. Comg.
H Battery R.H.A.

The Officer Commanding Royal
Horse Artillery.

I BEG to inform you, in addition to the above, that the guns have fired 150 rounds of blank ammunition, and have travelled 224 miles during the quarter.

(signed) *E. Michell*, Lieut.-Col.
Woolwich, 17 Nov. 1862.

Extracts from Diary of Armstrong Guns, I Battery, Horse Brigade, Royal Artillery, quarter ending 30 September 1862.

Dublin, 1 October 1862.

Class 1. Defects of guns or sights:—I consider the deep notch in the breech tangent sight objectionable for accurate laying; and according to the present order for laying the guns it entails the necessity of two operations, one for the line, and the other for the elevation; and consequently when the gun is laid it is not possible, at a glance, to judge of its accuracy.

The trunnion sights are so loose in their sockets that they interfere materially with accurate shooting.

One breech tangent sight, No. 48, Royal Gun Factory, appears to be improperly cut, and requires constant left deflection to correct it; the gun shoots well with another sight.

Class 2. Nil.

Class 3. Nil.

Class 4. Nil.

Miles marched during the quarter about 331.

Rounds blank: fired about 210 per gun.

Rounds service: fired about 20 per gun.

(signed) *W. B. Saunders*,
Capt. R.H.A.

Special Report on securing tangent sights in Sockets.

I HAVE not found that these sights are insecure in their sockets, even in moving over rough ground.

(signed) *W. B. Saunders*,
Capt. R.H.A.

A. Phillpotts, Col. Royal
Horse Artillery.

Sir, Dublin, 20 October 1862.

I HAVE the honour to inform you that Lieut. Walton reported to me this morning that a concussion fuze in charge of No. 3 sub-division of the battery under my command, had burst in the fuze box; on making inquiry into the circumstances of the case, I ascertained that the accident must have occurred from one of the concussion fuzes having been left in the tin box alone; the other having been expended at practice. A single fuze in this position would have considerable play, and this doubtless

less caused it to explode; no injury of any kind resulted to the other fuzes in the tray, or to the tray itself; the lid only being slightly blackened. I have removed all the single concussion fuzes from the boxes; and beg to suggest that in future when a single fuze is expended its place should be immediately supplied in the small tin box by one of the serge covered plugs from the shell, which will effectually keep it in its place, and prevent any play, when the limber is in motion.

I have, &c.
(signed) *W. B. Saunders*,
Capt. R. H. A.

The Officer Commanding Royal
Horse Artillery, Ireland.

Royal Horse Artillery Office,
Dublin, 20 Nov. 1862.

Forwarded to the Officer Commanding Royal Horse Artillery, Woolwich.

(signed) *A. Phillpotts*, Col. R. H. A.

Forwarded for the consideration of the proper authorities, and shall be much obliged if it is attached to the September diaries.

(signed) *D. J. Wood*,
Col. Comg. R. H. A.

Quarterly Report on Armstrong Guns and Carriages of K Battery, 1st Horse Brigade, Royal Artillery.

Dublin, 30 September 1862.

Class 1. Defects of guns and sights:—The sights do not fit properly in the sockets. There is sufficient play to admit of considerable error in laying.

Class 2. Defects of carriages special to Armstrong equipments:—None.

Class 3. Defects of carriages having no particular reference to Armstrong equipments:—The rear footboards of the waggon-bodies are too narrow.

Class 4. Complaints peculiar to Armstrong ammunition and small stores:—The time fuzes used at practice were very uncertain.

Number of rounds of service ammunition fired per gun, 20.
Number of blank cartridge, 180.
Number of miles travelled by gun carriages, 280.
Number by waggons, 60.

(signed) *C. G. Arbuthnot*,
Bt. Major, R.H.A., Comg.
K Battery.

A. Phillpotts,
Colonel, R.H.A.

The Commanding Officer Royal
Horse Artillery, Dublin.

Sir, Dublin, 1 January 1863.

I HAVE the honour to report on the Armstrong guns for the months of October, November and December 1862.

Class 1. Defects of guns or sights:—I have nothing to notice under this head, except that during the experimental practice carried on, on the 20th November, a shell burst in No. 7 gun (Royal Gun Factory), whereby the rifling was considerably flawed.

Class 2. Defects of carriages, special, to Armstrong equipment:—There is nothing to call for remark under this heading.

Class 3. Defects of carriages, having no particular reference to Armstrong equipment:—Nothing has occurred during the quarter to enter in the diary under this head.

Class 4. Complaints peculiar to Armstrong ammunition and small stores:—During the annual practice carried on in October it was observed that the time fuzes gave the most uncertain results, many of them bursting very short, and others being blind.

At the experimental practice considerable difficulty was experienced in getting the cartridges into the guns, owing to the lubricating wads being too large.

Number of rounds fired, service, 116 per gun.
Number of rounds, blank, 61 per gun.
Number of miles travelled, 108.

(signed) Col. *Phillpotts*, R. H. A.,
Dublin.

I have, &c.
(signed) *F. T. Winnyates*,
Capt., R. H. A.

Royal Horse Artillery Office,
Dublin, 3 Jan. 1863.

Forwarded to the Officer Commanding Royal Horse Artillery, Woolwich.

A. Phillpotts,
Colonel, Royal Horse Artillery.

Sir, Dorchester, 5 January 1863.

IN forwarding my December quarter report of the Armstrong battery under my command, I have the honour to make the following remarks:—

Guns, Royal Gun Factory.

Class 1. Defects of the guns or sights:—The tangent sights have been ordered to the Royal Arsenal.

No. 22 gun, when issued in February 1862; "slight flaw 30" from muzzle R, and 11 in D."

At the present date there is a deep fissure in the rifling 2 feet 7 inches from breech, a slight flaw 11 inches from muzzle, and a crack in the chamber.

No. 23 gun. When issued a slight flaw 43·5 up and 40" R; at present date a deep fissure half inch from chamber.

No. 24 gun. When issued, "Clear." At present date a deep long crack in chamber 1½ inches from the rifling; another, slighter crack, 5 inches from rifling.

26 gun. When issued slight flaw 43·5 L. At present date a crack through the metal near the muzzle; various slight flaws in the rifling. This gun is, I think, unsafe.

No. 27 gun. When issued slight flaw 17" up. At present date the same.

No. 29 gun, "Clear."

Class 2. "Defects of the carriages, special, to Armstrong equipment":—Nothing to report.

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Class 3. "Defects of the carriages having no particular reference to the Armstrong equipment:" —Nothing to add in addition to my last quarterly report. I have painted the carriages at my own expense.

There is no injury to the lead coatings of the shells.

Class 4. "Complaints peculiar to Armstrong's ammunition and small stores:"—Nothing to report. The shell-plugs have string loops, and are of gun metal.

The battery during the quarter has fired 300 rounds of shot and shell, and travelled about 178 miles.

(signed) *L. G. Paget*, Capt. H. A.,
Com. B Battery, 1st H. B., R. A.

Colonel Sir *David Wood*, K. C. B.
Commanding 1st Horse Brigade.

Sir, Aldershot, 1 January 1863.

I HAVE the honour to state that I have nothing extraordinary to report with reference to the equipment of my battery during last quarter.

I have, &c.
(signed) *H. J. Hay*, Major, R. H. A.,
Commanding C Battery.

Number of Rounds of Blank and Service fired during the quarter ending 31 December 1862.

Gun.	Blank.	Service.
R. G. F., No. 52 -	2	0
„ No. 57 -	2	0
„ No. 58 -	2	0
„ No. 59 -	2	0
„ No. 60 -	2	0
„ No. 61 -	2	0

Distance travelled by each gun; about 30 miles.

(signed) *H. J. Hay*,
Major, Royal Horse Artillery.

Forwarded to the officer commanding the Horse Brigade.

(signed) *G. T. Devereux*,
Colonel, Royal Horse Artillery.
2 January 1863.

Sir Woolwich, 1 January 1863.

WITH reference to the Armstrong diary of the battery under my command, for the quarter ending 31st December 1862, I have the honour to report as follows:—

Class 1. Defects of the guns or sights:—In the month of October 1862 four of the battery guns were sent to Shoeburyness to be used at practice; on their return from that station the whole of the guns of the battery were inspected by a Board of officers; and the following is the result of the examination:—

No. 1 gun (37—R. G. F.—1862.) "A slight crack, apparently opening of a coil, inside the bore, under portion of metal at about 14 inches from muzzle; this gun has recently returned from Shoeburyness, having fired 153 rounds at practice while there."

No. 2 gun (34—R. G. F.—1862.) "Rifling considerably dented about 19 inches from the muzzle, from the premature explosion of a shell; this gun has recently returned from Shoeburyness, having fired 41 rounds at practice while there, and not having been used after the discovery of the injury."

No. 3 gun (33—R. G. F.—1862.) "Rifling dented about 27 inches from muzzle, a slight crack, apparently opening of a coil, inside of bore, about 13 inches from muzzle; this gun has recently returned from Shoeburyness, having fired 82 rounds while there."

No. 4 gun (40—R. G. F.—1862.) "Rifling dented about six inches from muzzle, coil cracking externally at base of chase; this gun has recently returned from Shoeburyness, having fired 198 rounds at practice while there."

No. 5 gun (35—R. G. F.—1862.) "Flaws inside bore, about 18 inches from muzzle, also external crack about 19½ inches from muzzle, both from opening of coils; this gun was not at Shoeburyness, and has fired only 295 rounds of blank ammunition since being in possession of the battery."

No. 6 gun (38—R. G. F.—1862.) "Three flaws or cracks inside of bore respectively, at about 12, 16 and 24 inches from muzzle; this gun was not at Shoeburyness, and has fired only 295 rounds of blank ammunition since being in possession of the battery."

Class 2. Defects of the carriages, special, to Armstrong equipment:—Nil.

Class 3. Defects of the carriages, having no special reference to Armstrong equipment:—Nil.

Class 4. Complaints peculiar to the Armstrong ammunition and small stores:—There is nothing to report in this class, with the exception of 13 segment shells, which, on applying the 9-pounder high gauge, were found to have become so much enlarged at the base as to prevent their passing through the gauge.

The guns have been travelled since the last report about 60 miles.

(signed) *G. J. Shakerley*, Capt. R. H. A.,
Commanding D Battery, R. H. A.

The Officer commanding
Royal Horse Artillery,
Woolwich.

Quarterly Report of Armstrong Guns, of E Battery, 1st Horse Brigade, Royal Artillery.

Woolwich, 1 January 1863.

Class 1. Nothing to report.

Class 2. Nothing to report.

Class 3. Nothing to report.

Class 4.

Class 4. Sixteen segment shells too high in gauge.

Number of Gun.	Description.	Number of Rounds fired during the Quarter ending 31 Dec. 1862.		Number of Miles travelled during the Quarter.
		Blank.	Service.	
54	R. G. F.	nil	nil	70
55	R. G. F.	nil	nil	70
56	R. G. F.	nil	nil	70
62	R. G. F.	nil	nil	70
63	R. G. F.	nil	nil	70
64	R. G. F.	nil	nil	70

(signed) *A. M. Calvert*, Capt., R. H. A.,
Commanding E Battery,
1st Horse Brigade, R. A.

F Battery, 1st Horse Brigade, Royal Artillery.

Report on Armstrong Equipments for the Quarter ending 31 December 1862.

Woolwich, 1 January 1863.

Class.	Defect.
1	Gun, No. 2, has a heavy flaw, as from coil openings, about two inches from muzzle; threads of twist are rather injured. Gun, No. 65, has a long, but slight opening over an extent of 10 threads of the twist. Gun, No. 66, has a slight opening near muzzle. Gun, No. 67. has a slight opening nearly half-way up the chase. Gun, No. 68, has a long, but slight opening over an extent of 7 threads, one inch from the muzzle; slight openings up chase. Gun, No. 69, has some trifling appearance of openings up chase. *Remarks.*—All these reported instances of injury to the bore were noticed before the annual practice (which was the only occasion on which the guns were fired by the battery with service ammunition), and none of them have, as far as I can ascertain, increased, with the exception of that in No. 2 Gun, which is much larger, and appears to have had some violent shock. Nos. 66 and 67 were not at the practice, and have not been fired, except with blank ammunition. A special report to this effect has already been made.
2	Nil.
3	Nil.
4	Forty-one segment shells too high in gauge.

Rounds, Ammunition, Service, — Fired during quarter,—
Gun, No. 2 - 10 shot, 20 shell.
„ 65 - „ „ 15 „
„ 68 - 10 „ 20 „
„ 69 - „ „ 15 „

Remarks.—The remainder fired during the practice was returned in last quarter.

Rounds, Ammunition, Blank, — Nil.

Miles travelled:—54 miles.

Where from:—Royal Gun Factory.

(signed) *David Fraser*,
Capt. R. H. A., Lt. Col. Comg. F Battery.

Quarterly Report of Armstrong Guns of G Battery, 1st Horse Brigade, Royal Artillery. App. No. 76.

Aldershot, 1 January 1863.

Class 1. Nothing to report.
Class 2. Nothing to report.
Class 3. Nothing to report.
Class 4. Nothing to report.

Number of Gun.	Description.	Number of Rounds fired during the Quarter ending 31 Dec. 1862.		Number of Miles travelled during the Quarter.
		Blank.	Service.	
9	R. G. F.	25	nil	117
4	R. G. F.	25	nil	117
6	R. G. F.	25	nil	117
3	R. G. F.	25	nil	117
8	R. G. F.	25	nil	117
5	R. G. F.	25	nil	117

(signed) *Francis Lyon*, Capt.,
Comg. G Battery, R. H. A.
(signed) *G. T. Devereux*, Col.

To the Officer Commanding
Royal Horse Artillery, Woolwich.

Sir, Woolwich, 1 January 1863.

I HAVE the honour to transmit my report upon the Armstrong equipment attached to the battery under my command, for the quarter ending 31st December 1862.

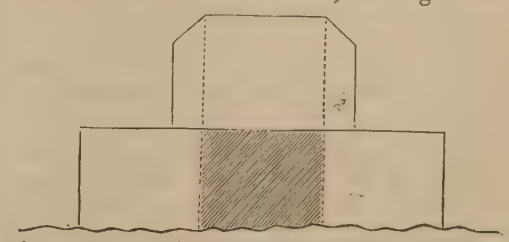
Class 1.—Guns and Sights:—During the late practice at Shoeburyness, the sights were found very faulty and troublesome to lay with, from the side notch and irregular shape of the tangent sight, and the centre point of the trunnion sight being so far below the level of the side-pieces.

These last are also somewhat insecure in their sockets.

Class 2.—Carriages (special reference to Armstrong Guns).—In my opinion the addition of the "traversing bar" would greatly facilitate the use of these guns, both in rapidity and accuracy of fire, and if, as I was informed, the extra weight is but a few pounds, it would seem a desirable addition; and it might perhaps be arranged without any further raising the centre of gravity, or complicating the carriage.

New linings have been issued for the concussion fuze boxes, but no orders have been issued to put the consussion fuzes into them, as the doing so would necessitate the opening the waterproof tin boxes in which they are now secured. I would ask whether it is thought desirable to dispense, now on home service, with that protection.

These linings, as before reported, have considerable play in the tin boxes, which are liable to be damaged; were they made of single pieces of tin cut somewhat in this form, the edges would,



when put together, overlap, and being soldered would be pretty strong.

Class 3. Carriage, no special reference to Armstrong equipment:—I would remark on the mode of

App. No. 70.

of carrying the spare wheel, as now carried, it is very troublesome to get on or off; as the carriage must be unlimbered, the perch held up, and the drag-chain removed from its place; this would take time, and further would occupy a good many men. Its present position on that axletree now would not be very secure, I should think, if it were necessary to move at any increased pace over rough ground.

Class 4. Ammunition:—On the issue of the high gauge for the shells, about sixty of those projectiles were found to be set up, and unable to pass through it; and although the order is to file them down, and make them fit, I would observe that this only meets the difficulty partially, while with much use and travelling they might be set up again, and have to be filed till all the lead was off and the rifling affected. I proposed, in July, that the limbers should be lined or padded, or some tow issued to pack the shells in; and this would, I think, go far to remedy the evil.

Owing to the guns being at Shoeburyness, they have only travelled about seven miles this quarter, and have fired no blank ammunition.

Of practice on service they have fired as follows:—

No. 36	231	rounds.
„ 39	235	„
„ 41	233	„
„ 42	171	„
„ 43	—	
„ 44	—	

The bores of Nos. 41 and 42 have been scored by the premature explosion of shells; but the damage is supposed to be slight and repairable.

I have, &c.
(signed) *Edward Michell*, Lieut. Col.,
Comg. H Battery, 1st Horse Brigade, R. A.

The Officer Commanding Royal Horse Artillery.

Royal Barracks, Dublin,
Sir, 31 December 1862.

I HAVE little to remark on the armament and equipment of the battery under my command this quarter.

Class 1. Defects of guns or sights:—The annual practice was completed during the quarter, and 100 rounds were fired in rapid succession from each gun, on the 20th November, to test them. No imperfection was discovered in any of the guns, beyond some slight dents caused by shell bursting in the bore.

Class 2. Defects of carriages special to Armstrong equipments:—Nothing to report.

Class 3. Defects of carriages having no particular reference to Armstrong equipments:—Nothing to report.

Class 4. Complaints peculiar to Armstrong ammunition and small stores:—A concussion fuze exploded in the fuze-box, probably on the road to the practice range. It appears that on the previous day's practice, one of the two fuzes in the box was used; the one remaining had therefore considerable play, and was exposed to much jolting. Probably, if a serge-covered plug was put in the box in such a case, it would prevent a similar accident. The wooden linings of the time fuze-boxes get broken by the jolting of the carriages.

Rounds fired during the quarter:—
With shell, 125 per gun.
Blank, 46 per gun.
Marched about 152 miles.

I have, &c.
(signed) *W. A. F. Strangways*,
Capt. R.H.A., Comg. I Battery, R.H.A.

The Officer Commanding Royal Horse Artillery, Ireland.

Royal Horse Artillery Office, Dublin,
2 January 1863.

Forwarded to the Officer Commanding Royal Horse Artillery, Woolwich.

(signed) *A. Phillpotts*,
Colonel, R.H.A.

QUARTERLY REPORT on Armstrong Guns and Carriages of K Battery, 1st Horse Brigade, Royal Artillery.

Newbridge, 4 January 1863.

Class 1. Defects of guns and sights:—The sights do not fit properly in the sockets; there is sufficient play to admit of considerable error in laying.

Class 2. Defects of carriages special to Armstrong equipments:—None.

Class 3. Defects of carriages having no particular reference to Armstrong equipments:—The rear footboards of the waggon bodies are too narrow.

Class 4. Complaints peculiar to Armstrong ammunition and small stores:—None.

Number of rounds of service ammunition fired per gun:—None.

Number of blank cartridges fired per gun—3·5.

Number of miles travelled by guncarriages—130.

Number of miles travelled by waggons—77.

(signed) *C. G. Arbuthnot*,
Bt. Major, R.H.A., Comg. K Battery.

The Commanding Officer Royal Horse Artillery, Dublin.

Royal Horse Artillery Office, Dublin,
5 January 1863.

Forwarded to the Officer Commanding Royal Horse Artillery, Woolwich.

(signed) *A. Phillpotts*,
Colonel, R.H.A.

Sir, Woolwich, 15 April 1863.

I HAVE the honour to forward the diaries for the Armstrong guns, for the quarter ending the 31st March 1863. I beg to bring under your notice the effect produced on the shot by travelling in the ammunition waggons, rendering it impossible to load the guns with it, after it has travelled some distance, without hammering it or filing down the leaden coating at the bottom of the

the shot, which is a most serious objection to this description of ammunition.

I have nothing to add to the report I made at the quarter ending December 1862, as there has been no gun practice carried on by the brigade.

I have, &c.
(signed) *D. J. Wood*, Colonel,
Commanding 1st Royal Horse Brigade, R.H.A.

Deputy Adjutant General,
Royal Artillery.

Sir, Dublin, 30 March 1863.

I HAVE the honour to forward the accompanying extracts from the Armstrong Gun Diary of this (A) Battery, Royal Horse Artillery, for the quarter ending 31st March :—

Class 1. No. 7 gun, copper ring of vent-piece cracked.

Classes 2 and 3. No report.

Class 4.—

Royal Gun Factory.	Rounds (Service) Fired.	Rounds (Blank) Fired.	Miles Travelled.
No.			
7	25	21	90
16	25	17	90
20	26	18	90
28	26	20	90
30	21	20	90
32	21	21	90

I have, &c.
(signed) *G. Le M. Tupper*, Capt. R. H. A.,
(Lieutenant Colonel.)

Colonel Phillpotts,
Commanding Royal Horse Artillery,
Dublin.

Royal Horse Artillery Office,
Dublin, 31 March 1863.

Forwarded to the Officer Commanding Royal Horse Artillery, Woolwich.

(signed) *A. Phillpotts*, Colonel, R. H. A.

Sir, Dorchester, 31 March 1863.

I HAVE the honour to forward my quarterly remarks on the Armstrong equipment under my command:—

Class 1. Defects of the guns or sights :—Since my last report, No. 26 Gun has been returned to the Royal Arsenal, and a new gun, No. 92, issued.

Class 2. Defects of the carriages special to Armstrong equipment:—"Nothing to report."

Class 3. Defects of the carriages having no particular reference to the Armstrong equipment:—"Nothing to report."

Class 4. Complaints peculiar to Armstrong ammunition and small stores :—"Nothing to report." The shell-plugs have string loops, and are of gun-metal. There is no injury to the lead coatings of the shells. The battery, during the quarter, has travelled about 125 miles, and fired 60 rounds of blank ammunition.

I have, &c.
(signed) *L. G. Paget*, Capt. H. A.
Comg. B Battery, 1st H. B., R. A.

Colonel Sir David Wood, K. C. B.,
Commanding 1st Horse Brigade,
Woolwich.

Sir, Aldershot, 1 April 1863.

I HAVE the honour to state that I have nothing to report respecting the guns of my battery during the last quarter.

But last month, on the shell being gauged, a large proportion were found that would not pass through the gauge; they were reduced, however, by being beat with a mallet.

I have, &c.
(signed *H. J. Hay*, Major, R. H. A.
Comg. C Battery, R. H. A.

Number of Rounds of Blank and Service fired during the Quarter ending 31st March 1863.

	Blank.	Service.
R. G. F., No. 52 -	65	Nil.
„ No. 57 -	60	„
„ No. 58 -	64	„
„ No. 59 -	63	„
„ No. 60 -	63	„
„ No. 61 -	63	„

Distance travelled by each gun, 200 miles.

(signed) *H. J. Hay*, Major, R. H. A.

Colonel the Honourable G. T. Devereux,
Royal Horse Artillery, Aldershot.

Forwarded.

(signed) *G. T. Devereux*, Col., R. H. A.
2 April 1863.

Woolwich, 1 April 1863.

ARMSTRONG DIARY of "D" Battery, Horse Brigade, Royal Artillery, for the Quarter ending 31st March 1863.

Class 1. Defects of the guns or sights :—None.

Class 2. Defects of the carriages special to Armstrong equipments :—None.

Class 3. Defects of the carriages having no special reference to Armstrong equipments :—None.

Class 4. Complaints peculiar to the Armstrong ammunition and small stores:—The segment shells were gauged with the 9-pounder high gauge, and 59 were found to have become so much enlarged

App. No. 70. at the base as to prevent them passing through the gauge.

Drills performed during the Quarter ending 31st March 1863.

Date.	Nature of Drill.	Number of Rounds fired per Gun.	Distance Travelled.
January 6	Marching order - Brigade -	- -	8 miles.
„ 13	Ditto - - Garrison	- -	10 „
„ 20	Ditto - - Brigade -	- -	10 „
„ 27	Ditto - - Garrison	- -	9 „
February 3	Ditto - - Brigade -	- -	8 „
„ 10	Ditto - - Garrison	- -	9 „
„ 16	Gun drill - - Captains	- -	6 „
„ 17	Marching order - Brigade -	- -	8 „
„ 24	Ditto - - ditto -	- -	10 „
March 10	Review order - Garrison	2	3 „
„ 12	Marching order - ditto -	8	5 „
„ 18	Gun drill - - Captains	- -	6 „
„ 23	Ditto - - ditto -	- -	6 „
„ 24	Ditto - - ditto -	- -	6 „
„ 25	Ditto - - ditto -	- -	6 „
„ 27	Ditto - - Adjutant	- -	6 „
„ 30	Ditto - - Captains	- -	6 „
	Totals - -	60	122 „

(signed) *J. H. Denne*, Capt., R. H. A.,
Commanding D Battery, Horse Brigade,
Royal Artillery.

Woolwich, 1 April 1863.

Quarterly Report on the Armstrong Equipment attached to E Battery, 1st Horse Brigade, Royal Artillery.

Class 1. Nothing to report.

Class 2. Nothing to report.

Class 3. If the picket-posts and the handles of all the side-arms were painted, much labour would be saved.

Class 4. The leaden coating of the segment shells get injured and above gauge with travelling, and have to be filed before the shell can be used; constant filing will considerably reduce the weight of the shell.

Gun.	Distance Travelled.	Rounds Fired.
	Miles.	
No. 54 -	137	9 blank.
No. 55 -	„	„
No. 56 -	„	„
No. 62 -	„	„
No. 63 -	„	„
No. 64 -	„	„

(signed) *A. M. Calvert*, Captain,
Commanding E Battery, 1st Horse
Brigade, Royal Artillery.

F Battery, 1st Horse Brigade, Royal Artillery,
Woolwich, 1 April 1863.

Report on Armstrong Equipment for the Quarter ending 31 March 1863.

Class.	Defects.
1.	None but those already reported, and which do not materially affect the guns.
2.	Nil.
3.	The small central ammunition boxes for fuzes and tubes are not water-tight. *Remarks.*—Supposed to be owing to the canvas not being turned down below the iron rims, but cut short off.
4.	Nil.
Fired rounds (service).	Nil.
Ditto (blank)	Nine.
Miles travelled.	138.
Where constructed.	Royal Gun Factory.

(signed) *David Fraser*, Capt., R. H. A. (Lt.Col.)
Commanding F Battery, 1st Brigade,
Royal Horse Artillery.

To the Officer Commanding
Royal Horse Artillery,
Woolwich.

Aldershot, 31 March 1863.

Quarterly Report of Armstrong Guns of G Battery, 1st Horse Brigade, Royal Artillery.

Class 1. Nothing to report.

Class 2. Nothing to report.

Class 3. Nothing to report.

Class 4. Nothing to report.

Number of Guns.	Description.	Number of Rounds fired during the Quarter.		Number of Miles travelled during the Quarter.
		Blank.	Service.	
9	R. G. F.	72	nil	117
4	R. G. F.	72	nil	117
6	R. G. F.	71	nil	117
3	R. G. F.	71	nil	117
8	R. G. F.	71	nil	117
5	R. G. F.	71	nil	117

(signed) *Francis Lyon*, Capt., R.H.A.,
Commanding G Battery, 1st Horse
Brigade, Royal Artillery.

To the Officer Commanding,
1st Horse Brigade, Royal
Artillery, Aldershot.

Forwarded.

(signed) *G. T. Devereux*,
Colonel, R.H.A.

H Battery, Woolwich,
Sir, 3 April 1863.

I HAVE the honour to forward my report on the Armstrong equipment of the battery under my command, for the quarter ending 31st March 1863:

Class 1. Guns and sights are still in the Royal Arsenal. Guns lent to the battery for drill purposes on the 12th March:—Nothing to report.

Class 2. Defects of carriages, &c. special to Armstrong equipment:—Nothing to report.

Class 3. Defects of carriages, &c. having no special connexion with Armstrong equipment:—Nothing to report.

Class 4. Ammunition:—Nothing to report. Since the borrowed guns came from the arsenal, they have travelled about 30 miles, and fired 15 rounds of blank ammunition per gun.

I have, &c.
(signed) *Edward Michell*,
Capt., R.H.A., and Lieut. Col.

The Officer commanding
Royal Horse Artillery.

I Battery, Royal Barracks,
Sir, Dublin, 1 April 1863.

I HAVE no remarks to make for the preceding quarter on any of the four classes into which the Armstrong armament is divided. The shells have been regularly gauged, and no enlargement at the base detected.

Each gun was fired as follows:—

	Rounds (Blank).	Shot or Shell.
R. G. F., No. 47 -	24	None.
„ No. 48 -	24	
„ No. 49 -	24	
„ No. 50 -	24	
„ No. 51 -	24	
„ No. 53 -	24	

Each gun has travelled about 128 miles during the quarter.

I have, &c.
(signed) *W. A. F. Strangways*,
Captain, R.H.A.

The Officer Commanding Royal Horse Artillery, Portobello.

Royal Horse Artillery Office, Dublin,
2 April 1863.

Forwarded to the Officer Commanding Royal Horse Artillery, Woolwich.

(signed) *A. Phillpotts*,
Colonel, R.H.A.

QUARTERLY REPORT, completed from the Diary of Armstrong Guns of K Battery, Royal Horse Artillery.

Newbridge, 4 April 1863.

Class 1. Nil.

Class 2. Nil.

Class 3. The screws of the ferrets of the ammunition boxes have, in nearly all instances, slightly opened, but this defect has been remedied, as far as practicable, by the wheelers of the battery; in two instances it has been found necessary to place new fronts, and others will require similar treatment before long. I attribute this partly to the continuance of wet weather, and the carriages not having been painted since their issue to the battery.

Class 4. The bases of many of the shells are slightly enlarged, but not sufficiently so to prevent their passing through the gauge.

The gun-carriages have travelled an average of 50 miles in each month; the waggons about 18 miles the first two months, and about 30 miles the last month of the quarter.

The only ammunition fired during the quarter from the guns—a Royal salute.

I have, &c.
(signed) *Henry Thornhill*, Capt., R.H.A.,
Commanding K Battery, Royal
Horse Artillery,

The Officer Commanding Royal
Horse Artillery in Ireland,
Dublin.

Dublin, 6 April 1863.

Forwarded to the Officer Commanding Royal Horse Artillery, Woolwich.

(signed) *A. Phillpotts*,
Colonel, R.H.A.

War Office,
4 July 1863.

Alexander T. Tulloh, Major General,
Director of Ordnance.

Appendix, No. 71.

RETURN showing the COST incurred since the 31st March 1858 to the 31st March 1863, in converting the ROYAL GUN FOUNDRY into a Manufactory for ARMSTRONG GUNS.

DATE.	BUILDINGS.	MACHINERY.
	£. s. d.	£. s. d.
1858–59 - - - - - - - -	2,605 - -	998 - -
1859–60 - - - - - - - -	11,342 - -	68,553 - -
1860–61 - - - - - - - -	1,970 - -	66,453 - -
1861–62 - - - - - - - -	6,753 - -	19,941 - -
1862–63 - - - - - - - -	5,741 - -	1,836 - -
£.	28,411 - -	157,781 - -

This return shows not only the expense that has been incurred in converting the machinery then existing, so as to suit the manufacture of Armstrong Guns, but also whatever expense has been necessary for the purchase of new machinery, erection of additional buildings, &c. for this purpose. The above is taken from page 239 of Appendix to Report from the Select Committee on Ordnance, 25th July 1862.

J. Anderson,
Assistant Superintendent Royal Gun Factory.

RETURN of the Total Expenditure upon the ESTABLISHMENT at *Woolwich* for the Manufacture of IRON ORDNANCE, from the 1st day of January 1854 to the 31st day of March 1858, separately specified under the following Heads; viz.—

PERIOD.	Buildings.	Machinery.	Stores.	Salaries.	Wages.	Miscellaneous Expenses.	TOTAL.
	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.
1 Jan. 1854 to 31 March 1854 -	—	—	—	—	—	—	—
1 Apl. 1854 to 31 March 1855 -	- - -	- - -	1,690 3 6	- -	- - -	- -	1,690 3 6
1 Apl. 1855 to 31 March 1856 -	- - -	- - -	5,029 18 5	- -	- - -	- -	5,029 18 5
1 Apl. 1856 to 31 March 1857 -	59,927 4 7	2,608 14 3	4,419 19 -	- -	- - -	- -	66,955 17 10
1 Apl. 1857 to 31 March 1858 -	780 - -	34,891 9 8	13,210 15 9	- -	1,313 6 3	6,188 1 9	56,383 13 5
£.	60,707 4 7	37,500 3 11	24,350 16 8	*	1,313 6 3	6,188 1 9	130,059 13 2

* This heading has been left blank, inasmuch as no addition has been made under the head of "Salaries," in consequence of the erection of the new iron gun foundry; and if that branch ceased, the same superintendence and staff would be required.

Such additional expense, however, as has been incurred exclusively for the iron gun foundry, has been placed under the head of "Wages."

The above is taken from statement presented for House of Commons, 12 July 1858.

J. Anderson,
Assistant Superintendent Royal Gun Factory.

War Office, July 1863.

Alex. T. Tulloh,
Director of Ordnance.

Appendix, No. 72.

PAPER furnished by Captain *Scott*.

PAPER submitted, in compliance with the Right Honourable the Chairman's directions, contained in Question 4474, for Witness to put in a statement of his views, for insertion in the Appendix. This Witness now begs to do, in support of that portion of his evidence which states, that other systems of rifling, which possessed many advantages over the Armstrong plan, had been insufficiently tested, and that almost any other system of rifle-grooving would have yielded results superior to those obtained from the delicate grooving adopted into Her Majesty's Service—

1st. Because the rapid deterioration of rifled weapons, from the excessive strain now thrown upon them, would have been much lessened by a different grooving; and,

2dly. Because the waste of propelling power (which goes to the destruction of the gun), caused by forcing a hardened lead-coated projectile through the bore, and making it rifle itself in its passage out of the gun, would have been avoided.

And hence, had a different system of rifling (the present Armstrong guns could be re-rifled) been adopted, a greater penetration into armour plates could have been attained without unduly straining the ordnance; and were a simple iron projectile to be now adopted, the principal portion of the present enormous yearly expense incurred in practising the men would be saved to the country.

In the shunt guns now under trial, and proposed by Sir W. Armstrong for adoption as naval guns in lieu of his fine-grooved weapons, some expense can be saved, as the powder charge can, in practice, be reduced without incurring the danger of air space; but the shunt projectiles cannot, from being studded with zinc strips, be picked up and re-fired, as is the case with simple iron shot. The guns, however, possess the great advantage over the Service Armstrong of giving a flatter trajectory to their shot, as will be seen by reference to the following table, which is extracted from the results of firing against the Thorneycroft Shield at Shoeburyness, on the 13th June 1861, at 400 yards range. In this experiment the same charge of powder was used for the finely-grooved and shunt guns, which were both breech-loaders, and nearly identical in length and diameter of bore (7-inch), but not in weight of shot, which was actually greater for the gun which required the less elevation. This result is the more striking when the windage of the shunt gun is considered, and the absence of it in the finely-grooved weapon; and shows the great absorption of propelling power from the excessive friction caused by the passage of the lead-coated shot through the bore of the finely-grooved weapon.

The pitch of the rifling was nearly the same in both breech-loaders; but the best amount of pitch or twist, which is a matter of detail, is, from not having been tested by experiment, still unknown, though there can be little doubt but that a sharp rifle twist increases the strain upon the gun; but it is also evident that it increases, in a still greater degree, the accuracy and stability of the rifle projectile, and therefore accounts for the relative superiority of penetration attained by the Whitworth projectiles; which, from having iron bearings, can be fired from a gun rifled with a rapid spiral twist, without incurring the danger of shipping.

N.B.—All the following rounds were fired with cast-iron shot:—

No. of Round.	Nature of Ordnance.	Charge in Lbs.	Weight of Shot in Lbs.	Elevation.	Remarks.
2	Shunt - -	14	125½	40′	
4	110-pounder -	14	110½	47′	
5	Shunt - -	14	125½	42	
7	110-pounder -	14	110	47′	
8	Shunt - -	14	125½	42′	
9	110-pounder -	14	110	47″	These two shots hit at the same time, and near together.
,,	Shunt - -	14	125½	42′	
10	68-pounder -	16	67	½°	

That the shunt system of rifling, though possessing advantages over the fine-grooving, as already shown, brings a greater strain upon the gun than some other systems, is evident from Tables No. 1 and No. 2, which contain the results of the experiments carried out by the Resident Superintendent of the Gun Factories, in order to test the relative strain thrown upon the gun by various forms of rifling. Mr. Anderson says that—"For some time past a question has been frequently raised in regard to the tendency which different descriptions of rifling have to split the gun.

"The power required to give the rotatory motion to the projectile, through the agency of ribs or grooves in the gun, must necessarily cause an opposite straining in the gun, tending to open it, or else to break the metal without actually splitting.

App. No. 72.

"We can easily perceive that an inclined surface is more apt to split the structure than a flat or perpendicular surface; but there were no precise data in regard to the position in which different planes stood with respect to each other.

"In order to ascertain this point, experiments have been made in the Royal Gun Factories, by preparing cylinders of cast-iron, all of equal strength and area: these cylinders were bored and rifled on the several plans shown on the accompanying Table, and, to prevent the risk of error from any exceptional defect of any description, several of each sort have been experimented with.

"Into these rifled cylinders there were correctly fitted corresponding plugs of steel representing the projectile; these plugs were made to fit the part representing the gun, and being of steel, which is a stronger metal than the cast-iron cylinders, it was resolved to continue the experiments until a form of rifling was arrived at, in which the steel plug would be broken before the cylinder was split open.

"The experiment consisted in fixing one end of the plug, representing the projectile, in a frame which was immoveable, its other end being within the cylinder. The cylinder was fixed in the centre of a lever fulcrum, and capable of having a torsional motion given to it, by the application of weights on the extremity of the lever.

"The accompanying Table shows the weight required to produce fracture on the several plans of rifling, and the diagrams will explain the exact form of the arrangement of rifling in the several systems:—

"No. 1.

"Table of Experiments on Cast-iron Cylinders Rifled on various Systems.

No. of Diagram.	Name.	Nature of Rifling.	Breaking Weight in Tons at Circumference.	Remarks.
1	Mr. Lancaster's	Oval	7·02	
2	Experimental	Decagon	23·29	
3	Sir W. Armstrong's	Three-grooved shunt	25·65	
4	Commander Scott's	Three grooves, but only two ribs bearing.	27·95	
5	Mr. Whitworth's	Hexagon	28·07	
6	Commander Scott's	Two grooves opposite to each other.	29·00	
7	Experimental	Two grooves opposite to each other.	29·18	
8	Mr. Lynall Thomas's	Three ribs	35·09	
9	Commander Scott's	Three grooves	35·30	
10	Sir W. Armstrong's	Ten-grooved shunt	46·50	At this weight the plug broke, and the cylinders showed a slight crack."

By referring to Table 1, and taking the rounded rifle-grooves of Commander Scott for comparison with the shunt-grooves, it will be seen that when only two of the former bore the strain, they showed greater strength than the whole three grooves of the shunt; but when Scott's third groove is allowed to take its share of the work, then this system, from the absence of angles, gives a gun the power of sustaining one-third more strain than if rifled upon the three-grooved shunt plan. Allowing a proportionate ratio for the two grooves added in the powerful gun now being manufactured by Government for Commander Scott, then his five grooves would appear to be stronger to resist steady pressure than the 10 grooves given to the new shunt ordnance, and which, in Mr. Anderson's test, withstood a strain of 46·50, owing to the force being distributed over ten instead of three bearings. This increased number of grooves is attended, however, by the disadvantage of cutting up more of the surface of the gun's bore, and of adding something to the cost of rifling, and much to the expense of making and fitting the bearings of the projectiles.

There still remains a more important difference between the two systems compared, and which consists in the different means used for centring their projectiles. This is attained in Commander Scott's system by the peculiar form given to the rounded grooving, which causes it to centre the shot on the first pressure of the elastic fluid, and then preserves it concentric during its passage through the bore; but in the shunt, the flat rifle-bearings, having no power to raise the shot into the centre of the gun, allow it to rub along the bottom of the bore until its ribs touch the inclines which rise from each groove, upon which, and after the shot has attained a high velocity, a change of level and centring is effected.

On first starting, also, and being driven against the rifle bearings, the peculiar rounding of the concentric grooving prevents the blow which must necessarily jar a gun on the shots striking against flat bearings, which have no such means of easing it round into its position.

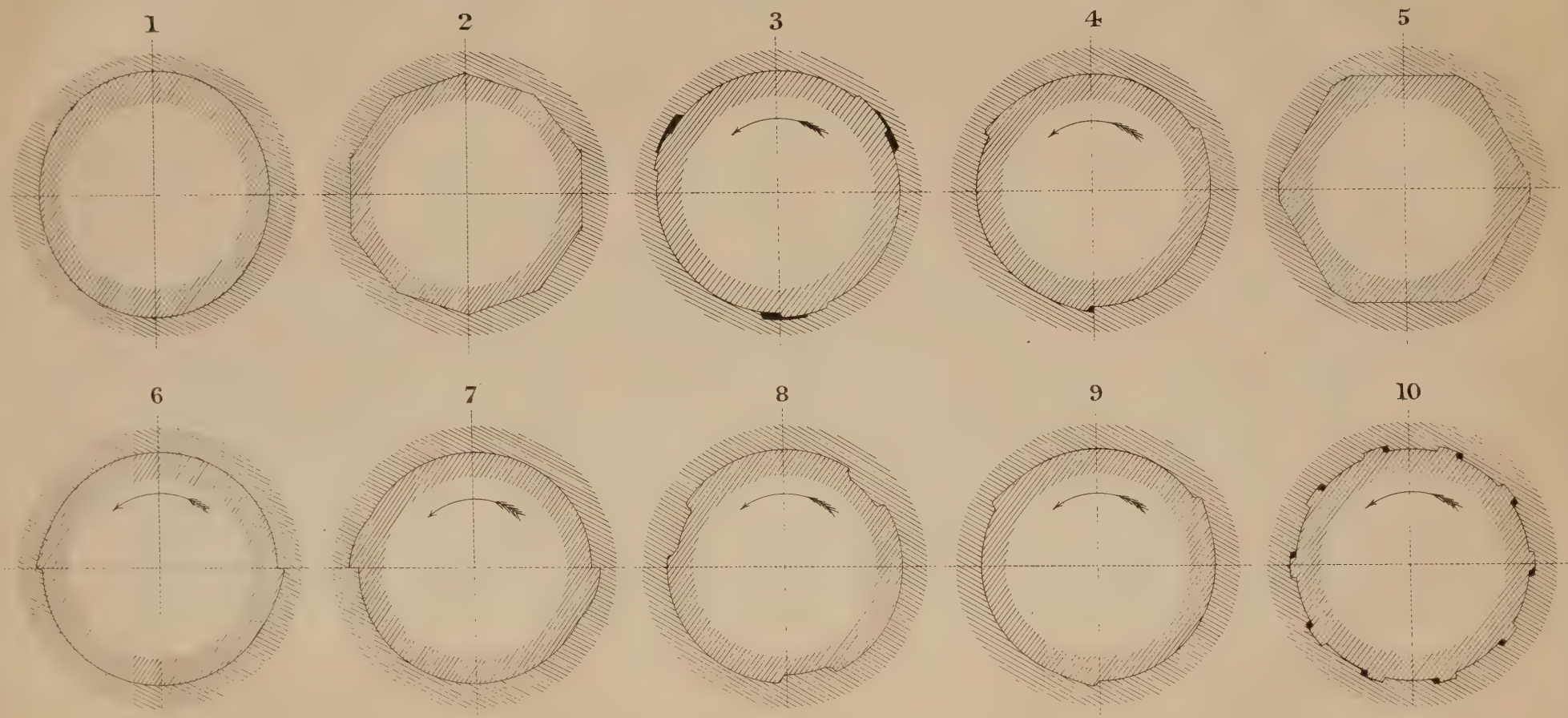
It may, perhaps, be thought that the strips of white metal which are let into the shunt projectiles for bearings will yield, and are therefore less liable to strain the gun. This is, however, an error; for these separate pieces are liable to become loose, and to yield sufficiently to slip over the grooves, after which they would cause a wedging action tending to split open the gun. Were similar strips deemed to be advisable, there would be no difficulty in letting them into projectiles to be fired from Commander Scott's gun; but although they would be, perhaps, less liable to be jarred out from their sockets, or to be injured by abrasion, from having no sharp edges, shot having such strips would be unfit for covering the landing of troops, and for firing near or across ships, and would be in other respects unsuitable for naval warfare.

(signed) *Robert A. E. Scott.*

18, Lines Grove, Lewisham,
Kent, S. E.

TABLE Nº 2.

ROYAL GUN FACTORIES.



ASSISTANT SUPERINTENDENT.

Nº 487. Ordered, by the House of Commons, to be printed, 23 July 1863.

Henry Hansard, Printer.

Appendix, No. 73.

STATEMENT of Cost of Ammunition, &c., for Armstrong Guns made in the Royal Laboratory, Woolwich, and at Elswick, to 31st March 1863. App. No. 73.

	Royal Laboratory, Woolwich.	Elswick.	Total.
	£. s. d.	£. s. d.	£. s. d.
300-pounder	30 5 1	—	—
150-pounder	365 12 6	—	—
120-pounder	19 5 1½	—	—
110-pounder	142,566 15 -¼	165,542 18 11	308,109 13 11¼
70-pounder	812 16 9½	—	—
40-pounder	69,863 18 9½	70,048 13 5	139,912 12 2¼
20-pounder	25,176 13 6½	19,144 1 1	44,320 14 7½
12-pounder	23,973 10 3½	59,977 6 1	83,950 16 4½
9-pounder	3,580 4 9½	—	—
6-pounder	2,623 14 8½	3,796 10 9	6,420 5 5¼
7-inch howitzer	13 14 2	—	—
For various natures of Guns:			
Adapters	2,547 8 11½	—	—
Bags, paper, for fuzes	676 16 2	—	—
Boxes, tin, for fuzes	403 13 4	—	—
Fuzes, various	11,282 - 2¼	77,490 15 8	88,772 15 10¼
Keys, shell or fuze	367 9 5¼	—	—
Plugs, various	8,216 14 9½	—	—
Primers	3,505 19 2	—	—
Sections of fuzes	52 - -¾	—	—
Sockets for cartridges	933 11 11½	—	—
Washes, brass, for fuzes	157 4 -	—	—
Total £.	297,169 8 10½	396,000 5 11	671,486 18 5½

18 July 1863.

G. W. Boxer,
Superintendent Royal Laboratory.

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ARMSTRONG GUNS:

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1. *Generally in Explanation or Approval of the Adoption of the Armstrong System:*

Witness was a Member of the Committee appointed in 1858 to report upon the best description of rifled cannon for field service, *Sir W. Wiseman* 118——This Committee was appointed in August 1858, and reported on the 16th November following, *ib.* 120, 121——Sundry details relative to the experiments made by the Committee before recommending the introduction of the Armstrong gun; evidence in support of such recommendation, *ib.* 122 *et seq.*

Witness considers the gun first adopted, that is, the field gun, an admirable weapon (although defects have recently been discovered), and is of opinion that the original adoption of this gun was properly arrived at, *Bingham*, 374, 375. 524. 533–539——Conclusion that no other gun has yet been brought to a condition superior to that of the Armstrong gun, and that the original adoption of the latter gun, in which witness concurred, was perfectly justifiable, *H. R. H. the Duke of Cambridge*, 1232–1234. 1248–1252——Conviction that we are ahead of any other country in the matter of rifled ordnance, *ib.* 1251.

Probability of the Armstrong guns being the best rifled guns that we could have adopted, *Coles* 1582–1600. 1614–1618——Opinion that the Armstrong field gun is the best rifled gun known, but that it has many defects, *Sir R. Dacres* 2184–2189. 2204.

The Armstrong gun was adopted in preference to the Whitworth gun, as having proved superior to it on all points in which the two were compared, *Noble* 3116–3121——The Ordnance Select Committee had no personal feeling whatever in favour of Sir W. Armstrong's gun, and were completely unanimous in recommending it as the best, *ib.* 3131, 3132.

Opinion that the public expenditure on the Armstrong gun was wisely incurred, *Hewlett* 3353, 3354. 3415–3417. 3434–3436——At present witness knows no better rifled

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1. *Generally in Explanation or Approval of the Adoption, &c.*—continued.

rifled gun than the Armstrong, but he has not seen the Whitworth gun properly tried, *Richards* 4075-4078.

Notwithstanding the enormous expenditure incurred, the experiments and the results obtained have been well worth their cost, *Duke of Somerset* 5219-5228——On the whole, witness considers that the course taken by the War Office with reference to the Armstrong gun was the best under the circumstances, *ib.* 5226-5228.

Statement to the effect that at the time of deciding, in 1861 upon the expenditure in 1861-62 upon Armstrong guns, there were no other guns to be put in competition with them, *Baring* 5230-5234.

Outline by the Committee of the circumstances connected with the introduction of the Armstrong field gun, *Rep.* iii., iv.——Opinion that the adoption of the Armstrong gun for special service in the field was fully justified, *ib.* iv.——The Committee have had no practical evidence before them that even at this moment any other method of constructing rifled ordnance exists which can be compared to that of Mr. Armstrong, *ib.*——Introduction of the Armstrong gun into the Navy adverted to, *ib.* v.——Complete adoption of the Armstrong system, upon the failure of experiments in the strengthening of cast-iron guns, *ib.*

2. *Exceptions taken to the Armstrong Guns, and the course pursued in regard to their complete Adoption:*

Opinion that the Committee which first decided in favour of the Armstrong gun came to a very hurried conclusion, and adopted too complicated a weapon, *Gardner* 73-80. 85-88——Witness adheres to the statement in his letter to the "Times" in November last, relative to the merits of his gun as compared with that of Sir W. Armstrong, *Whitworth* 1122-1124——The foregoing letter read; consideration thereon of the merits of witness's guns as compared with the Armstrong guns, *ib.* 1130——Evidence in support of the statement as to the coil principle not being new, *ib.* 1130. 1204-1213. 1320-1326. 2596.

Distinction between the Armstrong gun and witness's gun, that the tubes of the former are composed of welded iron on the coil principle, whilst witness has always used an inner tube made from a solid bar not coiled, *Whitworth* 1311-1319——Opinion that Sir W. Armstrong's principle is utterly wrong, *ib.* 1451. 1464.

Evidence to the effect that so extensive an adoption of the larger guns was not justifiable, the efficiency of these guns not having been assured by proper practice or experience, *Jerningham* 3656-3679. 3686-3689; *Wainwright* 3811, 3812.

Advantage to Sir William Armstrong, as an inventor, in his being present at trials with guns of other inventors in his capacity as Engineer of Rifled Ordnance, *Richards* 4053-4062—— Opinion that a proper competition should have been secured, with a view to the adoption of a more perfect weapon, before ordering supplies of Armstrong guns, &c., to the amount of 2,500,000 *l.*, *ib.* 4057, 4058. 4081, 4082.

Witness considers that the expenditure on the Armstrong naval gun was not wisely incurred, and adduces grounds for this conclusion, *Scott*, 4144 *et seq.*——Probability of the inventions of Mr. Britten and others not having been properly tested, because of a pre-determination in the authorities to make some plan of Sir W. Armstrong successful; official position of Sir W. Armstrong, and functions of the Ordnance Select Committee adverted to hereon, *ib.* 4252-4275——In 1860 and 1861 witness publicly expressed his objections to the principle of coil manufacture, *ib.* 4311——Disapproval expressed by witness on more occasions than one of the continuous and expensive manufacture of Armstrong guns, although a limited supply of them was doubtless justifiable, *ib.*

Witness disapproves of the Armstrong breech-loading system, and considers that its defects might have been ascertained with much less expenditure than has taken place, *Blakely* 4606——Respects in which the Armstrong system of coils is defective, whilst it has been superseded by a better system, involving the use of steel, *ib.* 4607-4609. 4626. 4685-4688. 5403-5415——Inexpediency of inventors being obliged to submit plans so that they shall come before an official who is himself an inventor; position of Sir W. Armstrong adverted to hereon, *ib.* 4773-4795. 4874-4880. 4892-4894——Objection mainly that the Armstrong system has been carried out so extensively, and at such an enormous subsequent cost without proper opportunities having been given to other inventors to bring forward their plans, and without satisfactory experiments having been carried out, *ib.* 4916-4922.

Paper furnished by Captain Scott in support of the conclusion that other systems of rifling which possessed many advantages over the Armstrong plan had been insufficiently tested, and that almost any other system of rifling would have yielded results superior to the delicate system which has been adopted, *App.* 583, 584.

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3. *Complaint by Captain Blakely as to the Armstrong Gun being an infringement of his Patent:*

Identity between the system of coils as applied to guns made for witness in 1855 and the system at the Arsenal, *Blakely* 4627. 4675-4678——Patent taken out by witness in February 1855 involving the principle of construction subsequently carried out by Mr. Armstrong; communication between witness and him on the subject, *ib.* 4628-4642. 4659——Sir W. Armstrong never gave any description of his system to witness in 1854 or 1855, *ib.* 4632-4637——Witness could not tell one of Sir W. Armstrong's guns from his own, *ib.* 4639.

Reference to a correspondence in 1859 between witness and the War Office relative to the alleged infringement of his patent, *Blakely* 4646-4649, 4662-4664——Statement showing the views of Sir W. Armstrong in elucidation of his plan of construction, *ib.* 4649——Conclusion arrived at by the Ordnance Select Committee in 1855 in regard to the principle of building the Armstrong rifled gun being somewhat similar to that proposed by witness, *ib.* 4657. 4659.

Explanation as to witness having, in 1859, commenced proceedings against the Elswick Company, and as to his having abandoned the proceedings in consequence of the communication going on at the time with Government upon the same subject, *Blakely* 4665-4670——Witness was advised that an action would not hold against Government, the Armstrong patent having become their property, *ib.* 4670, 4671.

With regard to the first gun made by Sir W. Armstrong, that is in 1854, the principle of construction was arrived at altogether independently of witness, *Blakely* 4677, 4678——The first gun made by witness, strictly on the coil principle, was in 1859, but he made guns on an analogous principle in 1855, *ib.* 5410-5412.

4. *Original Agreement between Sir W. Armstrong and Government:*

Copy of agreement entered into between Sir W. G. Armstrong and the Secretary of State for War, dated 15th January 1859, for a transfer to Government of the improvements and inventions of the former in rifled ordnance, *App.* 486——Memorandum defining Sir W. Armstrong's duties as Engineer for Rifled Ordnance, *ib.*——Copy of further agreement entered into between the Secretary of State for War and Sir W. G. Armstrong, dated 16th January 1859, *ib.* 488-490.

5. *Patent in the Hands of Government:*

Witness considers that the Armstrong system could not have been a valid subject to patent in 1858, as he had previously used it in 1855, *Blakely* 4657. 4677——Doubt as to what Sir W. Armstrong's patent really is, the specification being, under the Act of Parliament, kept secret, *ib.* 4672-4674. 4688.

Government could not have manufactured the guns without the patent; with it they can prevent manufacture by any other party, *Earl De Grey and Ripon* 5068-5074——It is provided by Act that the patent may be kept secret, and witness considers it unadvisable to produce it, *ib.* 5075-5081.

Doubt as to its being of much use to keep secret the patent of Sir W. Armstrong, *Anderson* 5555-5559.

Reference by the Committee to the assignment by Sir W. Armstrong of his interest in his patent to Government, and to the refusal of the Secretary of State for War to submit the patent to the Committee, *Rep.* iv.

6. *Drawing of original Armstrong Gun:*

Drawing of original Armstrong gun referred to in report of Sir W. G. Armstrong, dated 14th July 1855, *App.* 552.

7. *Improvement of the Guns from time to time:*

Progressive improvement since 1859, so that the present guns are much in advance of those then made, *Anderson* 567. 595. 704. 721——The guns have been greatly improved since the commencement, *Tulloh* 2680——Circumstance of the Armstrong gun having been much matured and strengthened by Mr. Anderson, *Scott* 4386-4396——Public expense at which the alterations and improvements in the Armstrong gun at Woolwich have been carried out, *Anderson* 5561-5565——Opinion that the improvements generally could not have been obtained for less than they have cost, *ib.* 5569.

8. *Total Number of Guns issued:*

Return of the number and different natures of Armstrong guns made respectively at the Gun Factory and at Elswick, and of the number issued for service, *App.* 379-381——List of Armstrong guns issued for service up to February 1863, showing where made; total of 2,370 guns issued, *ib.* 530.

9. *Statistics.*

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9. *Statistics of Expenditure:*

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Aggregate of 1,067,794 *l.* 16 *s.* 5 *d.* as the amount of payments and liabilities to the Elswick Company for Armstrong guns and projectiles, *Rep.* v.——Total of 1,471,753 *l.* 1 *s.* 3 *d.* as the expenditure in the manufacturing departments at Woolwich, *ib.*——The entire expenditure and liabilities at Elswick and Woolwich amount to 2,539,547 *l.* 17 *s.* 8 *d.*, *ib.*

10. *Limit now placed upon the manufacture:*

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See also *the Headings generally throughout the Index*, and the explanations in the Analysis of Evidence under the Heading of *Armstrong, Sir William George.*

Armstrong Projectiles. See *Projectiles or Shells.*

Armstrong, Sir William George, C.B., F.R.S. (Analysis of his Evidence.)—Was, until recently, Superintendent of the Royal Gun Factory, having been originally Engineer for Rifled Ordnance; his duties under each appointment were substantially the same, and were mainly of an engineering character, 3157–3162.

Reference to a certain War Office paper as showing that witness's gun was first brought to the notice of Government in December 1854; 3163——Completion of the first gun, a 3-pounder, in March 1855, it having been delivered to Government in the following July, after some experiments in the meantime, *ib.*——Former report by witness abverted to, showing that the fundamental idea of his system was to form a gun upon the principle of a fowling piece, and involved the use of twisted cylinders of wrought iron shrunk upon a steel centre or barrel, *ib.*

Principle laid down at first by witness as to the necessity of strengthening the gun in consequence of the substitution of an elongated solid projectile for a spherical bullet, 3163——Peculiarity of witness's gun, as made in 1855, in being mainly composed by coiling spirally long bars of iron into tubes and welding them upon the edges, *ib.*——There was nothing original in the built-up character of the gun, *ib.*——Great difficulty experienced by witness in perfecting the application of coil principle, although it may now appear easy enough to define how the coils are to be made, *ib.*——Denial that hydraulic presses had ever been made upon the coil principle as applied by witness, *ib.*

Opinion expressed from the first by witness, and now reiterated, that steel is the proper metal for the barrel of a gun, if only it can be obtained of uniform and proper quality, 3163——The steel barrel was in fact one of the chief peculiar features of the gun first made by witness for Government, *ib.*——Imprudence of any large use of mild steel or homogeneous iron until it can be produced of a sufficiently uniform quality, *ib.* In the meantime witness is satisfied that coiled barrels of wrought iron are the best alternative for steel, *ib.*

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Conclusion that it is entirely out of the question to make large guns on the principle of solid forged tubes, either of steel or iron, 3163——Concurrence between Mr. Whitworth and witness as to the expediency of using steel tubes if the proper quality of metal can be secured, *ib.*——Dissent from Mr. Whitworth's view that the external parts of the gun should be formed of steel cylinders instead of wrought-iron coils; important advantages of the latter, *ib.*

Statement showing that from the very first witness did not pledge himself exclusively to breech-loading guns, 3163——Explanation also that his views at first were limited to the introduction of an improved field-gun, *ib.*——Circumstances under which witness was led to substitute for the leaden projectile a case-iron hollow shot, thinly coated with lead, having a small percussion fuse affixed, *ib.*——Advantage of witness's segment-shell in its being convertible so as to be used either as solid shot, shrapnell-shell, or canister, *ib.*——Favourable report of the Committee on Rifled Ordnance, in November 1858, with reference to witness's projectiles, *ib.*

With regard to the Rifled Ordnance Committee having reported so completely in favour of the Armstrong gun and ammunition, witness contends that they could not have done otherwise, 3163.——Feeling of witness from the first that the application of breech-loading to large guns would involve inconvenience, *ib.*——Steps taken by him, in

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1859, towards applying a system of muzzle-loading to large guns; hence the shunt system, which has since been approved by the Ordnance Select Committee, 3163——Description of the shunt system and of its advantages, 3163-3166——Disadvantages of the principle of mechanical fit of hard substances or projectiles, as compared with the advantages of projectiles having a soft outer coating or thin covering of lead, 3165.

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Statement that where the charge and the weight of the projectile remain the same the initial velocity with a rifled gun is quite equal to that with a smooth-bore gun, 3167——Peculiar advantage of rifled artillery on account of the much greater efficacy of the projectile or shell over the shell used with smooth-bores, *ib.*——Opinion strongly adverse to the use of steel spherical shot, as compared with elongated projectiles, *ib.*

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With regard to the power of witness's guns to pierce armour-plates, it is not even yet decided what thickness or strength of plates artillerists may be called on to penetrate, 3225, 3226——Nor is it at all determined what the capability of ships for carrying heavy guns shall be, 3225——There are experimental guns that could pierce the "Warrior" target at 1,000 yards, but no such guns are in the service, nor is it reasonable to expect that there should be, 3226.

Several experimental or pattern guns which witness now has completed for the purpose of dealing with armour-plated ships, forts, or casemated defences, 3226, 3227——Favourable opinion of the Iron Plate Committee in regard to witness's 300-pounder muzzle loading gun of twelve tons, 3227——The largest gun now completed is a 600-pounder rifled muzzle-loader of 13½-inch bore, 3227——Grounds for concluding that it will be necessary to use guns of a very large calibre in order to destroy armour-plated ships, *ib.*——Opinion that nothing less than a bore of nine inches will be adequate for this purpose, *ib.*——Contemplated use on board ship of guns of greater weight than six tons, *ib.*

Evidence in support of the conclusion that no other alternative was open to Government than to incur the expenditure involved in the adoption of the system designed by witness, 3227, 3228——Decided condemnation of the alternative of rifled cast-iron guns; failure of these even when bound with wrought-iron hoops, *ib.*——Conclusion also that brass is a very unsuitable material for rifled guns, *ib.*——Unsatisfactory experience also in the case of homogeneous metal as hitherto used by Mr. Whitworth, 3228.

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Evidence showing that the Ordnance Select Committee would not have been justified if they had recommended the French field-gun in lieu of the Armstrong field-gun, 3228——Particulars as to the exceedingly satisfactory operation of witness's guns during the China war, *ib.*——Very satisfactory manner in which they bear rough work or exposure to weather, *ib.*

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Explanatory statement relative to five defective guns at Shorncliffe out of two batteries of twelve guns, 3230–3237——Satisfactory firing with twelve guns at Portsmouth; doubt as to these having been specially selected, 3237, 3238. 3244.

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With regard to the objections urged against breech-loading guns on account of their complexity, witness deprecates any change in favour of simplicity at the expense of efficiency, 3266——He contends that his guns up to and including 40-pounders are subject to very few liabilities to derangement, and possess the very highest efficiency, *ib.*——At the same time he does not commit himself to any blind adherence to what he has already accomplished, and is giving his anxious attention to the attainment of greater simplicity and increased efficiency, *ib.*——When his shunt system shall have been perfected it will be for the authorities to decide between the breech-loader and the muzzle-loader, each of which has its advantages, *ib.*

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[Third Examination.]—Explanation that the time fuzes now used in the navy are only a temporary expedient until a more perfect fuze can be introduced, 3438——Success anticipated from the new pattern fuze being introduced for the land service, 3438–3443——Good grounds for witness's confidence in the wrought-iron vent-pieces now used with the 9-pounders and 12-pounders; entire absence of failures since their use, 3444–3452.

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Copy of disclaimer and memorandum of alteration entered by Captain Blakely in March 1859 with reference to his patent in 1855 for improvements in ordnance, *App.* 534-536.

Communications from Captain Blakely to the Secretary of State for War in December 1860, and in January and February 1861, submitting the advantages of his system of ordnance, and offering to assign his patent to the Secretary of State for the sum of 500,000 *l.*, or to grant a license of manufacture under certain terms, *App.* 549–551——Refusal on the part of the Secretary of State to accept the foregoing terms, *ib.* 550, 551.

Offer made by Captain Blakely, in January and February 1861, to make a 12-inch bore gun, weighing ten tons, and correspondence between him and the War Office on the subject, *App.* 550–552——Report by the Ordnance Select Committee, dated 4 February 1861, upon the foregoing proposition of Captain Blakely; exception taken to the views laid down by him, *ib.* 551——Conditions under which it is suggested by the Ordnance Select Committee, and approved by the Secretary of State, that Captain Blakely should provide a 12-inch gun made on his principle, *ib.* 551, 552.

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Bombardment of Towns. For bombarding towns at a distance from ships, or for land service, the Armstrong gun is most valuable, *Earl of Lauderdale* 2147, 2148. 2155. 2162–2164.

Bore of Guns. Enumeration of the advantages and disadvantages respectively of small bores; increase of penetrating power in the former case, but only by sacrificing destructive effect, *Sir W. G. Armstrong* 3225. 3942, 3943——Smaller bore adopted by Mr. Whitworth than by witness, *ib.* 3225.

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Very exceptional character of the trial to which the battery supplied by witness to Shorncliffe was subjected, *Whitworth* 2571-2576——One hundred rounds were fired without lubrication, which witness had not considered was possible, *ib.* 2573-2575. 3018, 3019——The trial has served only to prove the great endurance of the guns, 2573-2575. 3020——Opinion as to the importance of further experiments with a view to the use of brass both for large and small guns, *ib.* 2611-2613.

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Statement by Mr. Whitworth relative to the satisfactory results obtained with three brass 24-pounder howitzers bored and rifled hexagonally by him, *App.* 401.

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BREECH-LOADERS:

1. *As to Breech-loaders Generally.*
2. *As to the Armstrong Breech-loader.*
3. *As to the Plan of Mr. Westley Richards.*

1. *As to Breech-loaders Generally:*

Consideration of the relative advantages generally of breech-loaders and muzzle-loaders, *Gardner*, 34. 48-56. 91-111; *Coles* 1620-1622; *Tulloh* 2823-2826; *Hewlett* 3318. 3333-3339; *Scott* 4425-4429——Witness objects not only to the Armstrong breech-loader, but to all breech-loaders he has yet seen, *Gardner* 112-114——Serious objection to a breech-loader as compared with a muzzle-loader, on account of the liability of the vent-pieces, &c. to give way, *Sir R. Dacres*, 2203.

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2. *As to the Armstrong Breech-loader:*

Objection to the Armstrong breech-loaders as consisting of so many separate parts, and as being too complicated for hard service in the field, *Gardner* 34. 48-50. 105-107. 112, 113——Favourable opinion of the breech-loader for field service, *Sir W. Wiseman* 282-288——The Armstrong gun is more complicated, and more easily disabled than the old gun used in the Navy, *Earl of Lauderdale* 2144, 2145. 2159, 2160——Witness considers that the Armstrong gun, or any other breech-loading, is decidedly unsuitable for the Navy, *Seymour* 2299. 2322.

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Objection to the Armstrong breech-loading arrangement, as not properly guarding against the escape of gas, *Blakely* 4682, 4683.

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3. *As to the Plan of Mr. Westley Richards:*

Approval of a trial of the suggestion of Mr. Westley Richards for improving the breech of the Armstrong gun, it being very desirable to overcome the evil arising from the vent-pieces, *Duke of Somerset* 5139-5141.

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BREECH-LOADERS—continued.

3. *As to the Plan of Mr. Westley Richards*—continued.

Report by the Ordnance Select Committee upon the system of breech-loading proposed by Mr. Westley Richards; expediency of a further trial of this system, *App.* 375.

See also *Accidents* (*Armstrong Guns*). *Durability or Endurance. Failures and Defects. Field Guns. Muzzle-loaders. Navy, The. Range of Guns. Rapidity of Fire. Vent-pieces. Wear and Tear of Guns. Whitworth Guns and Projectiles.*

Breech-screw (*Armstrong Guns*). Liability of the breech-screw to injury from the breaking of the vent-piece, *Gardner* 9. 14. 20. 23, 24——Injury to the screw in the case of eleven guns out of fourteen returned to the Gun Factory, *Anderson* 613. 643, 644.

Improvement since the failure of breech-screws in trials at Southsea, no failure of the improved pattern having since taken place, *Sir W. G. Armstrong* 3232——Explanation as to several instances of the breech-screws of the 12-pounders and 10-pounders having clogged, *ib.* 3574, 3575——Statement in explanation of the failure of the thread of the breech-screw in several of the earlier field service guns experimented upon at Shorncliffe; the guns are not disabled thereby, and the defect does not now exist in the guns now made, *ib.* 3580–3589——Failure of breech-screws in the case of the 12-pounders exclusively; trifling character of the majority of the defects on this score, *ib.* 3869.

Statements by Captain Jerningham and other officers explanatory of the results as regards the breech screws of the Armstrong guns with which experiments were made on board the "Cambridge," &c., *App.* 310 *et seq.*

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Advantages possessed by the guns of Mr. Bashley Britten, whereas they were never tried under the same conditions as the Armstrong gun, *Scott* 4168–4172. 4217–4249——Higher initial velocity obtained with Mr. Bashley Britten's gun in 1859 than with the Armstrong gun, notwithstanding which the former gun was not properly tried, *ib.* 4217–4249——Greater initial velocity of Mr. Britten's gun than of the Armstrong gun further adverted to, *ib.* 4311.

Mr. Bashley Britten's system of strengthening and rifling cast-iron guns in 1860 was supposed to be the best, his gun having stood 300 rounds without any danger, *Baring* 5233——Reference to the circumstance of Mr. Bashley Britten's system not having been applied to wrought-iron guns, although found the best with cast-iron guns, *ib.* 5246.

Letter, dated 8th July 1863, from Mr. Bashley Britten to the Chairman of the Committee, stating that he has never had proper opportunities of demonstrating the advantages of his system of rifled ordnance on anything like equal terms with other inventors, *App.* 558——Suggestions in this letter that each inventor should be allowed to have a gun constructed for him at the Royal Gun Factories, all the guns to be of a given weight, and their respective merits to be fairly tested, *ib.*

Brunel, The late Mr. Comment upon the statement of the Ordnance Select Committee that "the more modern and perfect development of the hexagonal system of rifling originated with the late Mr. Brunel," *Whitworth* 1102——Examination with reference to the original adoption by witness of the polygonal system of rifling; he disclaims having been led to the system in consequence of the previous adoption of it by Mr. Brunel, of which he was not at the time aware, *ib.* 2445, 2446. 2545–2551. 2602–2610.

Letter from Mr. Isambard Brunel to the Chairman of the Committee, dated 27 April 1863, enclosing certain correspondence of the late Mr. Brunel and of Mr. Westley Richards as establishing the fact that the former had, in 1852, conceived the idea of a polygonal rifle, and that Mr. Whitworth had subsequently been in communication with Mr. Richards on the subject, that is, in 1854, *App.* 402, 403——Communication from Mr. Westley Richards to Mr. Isambard Brunell, dated 30 June 1863, upon the foregoing question, *ib.* 548.

Butterley Company. The first guns, upon witness's principle, were made by the Butterley Company in the beginning of 1855, *Blakely* 4690——Immense endurance of a 9-pounder smooth bore gun made for witness by the Butterley Company, *ib.* 4690–4693.

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Cambridge, Field Marshal His Royal Highness the Duke of, K.G. (Analysis of his Evidence.)—Has been Commander-in-Chief since July 1856; 1214, 1215——Considers that the guns now in the hands of the Royal Artillery are, with present experience, as perfect as can be expected, 1216, 1217——The Committee of Artillery Officers, referred to by Colonel Bingham,

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Cambridge, Field Marshal the Duke of, K. G. (Analysis of his Evidence)—*continued.*

Bingham, were appointed by witness in order to inquire into certain alleged defects in the Armstrong field guns, 1218, 1219——About half these guns are lined, and it is a question whether they are not defective on that account, 1220. 1236.

Advantage if there were an independent inspection of all guns, after manufacture, at Woolwich, 1223–1228. 1253–1256. 1259——Great advantage also if there were an artillery officer at the head of the Gun Factory, 1223——Impropriety of the view expressed by Mr. Anderson, that he does not consider himself bound to abide absolutely by the sealed pattern, 1229——Responsibility primarily of the Ordnance Select Committee for the sealing of the pattern of the lined gun, 1230, 1231.

Conclusion that no other gun has yet been brought to a condition superior to that of the Armstrong gun, and that the original adoption of the latter gun, in which witness concurred, was perfectly justifiable, 1232–1234. 1248–1252——Impropriety of the alteration of pattern which led to the lining of some of the guns; this is now put a stop to, 1235, 1236. 1260——Expediency of an independent inspection of all Government manufactures, 1237, 1238.

Less trial of the Whitworth guns than of the Armstrong guns, owing very much to difficulties raised by Mr. Whitworth, 1239–1241——Impartial character of the Committee now appointed for testing the relative merits of the two guns, 1242–1247——Decided improvement if there were an officer at the head of all the Arsenal, 1255, 1256——Belief as to certain guns which recently proved defective at Shorncliffe having been lined guns, 1257–1262.

"*Cambridge,*" *H. M. S.* Return, from Her Majesty's ship "Cambridge," of the trials of Sir William Armstrong's rifled ordnance of different calibres since 1 January 1858, *App.* 309–319——Reports and letters, from the captain of the "Cambridge," relating to the experimental firing with the several descriptions of the Armstrong gun, and showing the several defects or accidents experienced, *ib.* 320–327.

Canada. Excellent manner in which the Armstrong guns sent to Canada bore the journey, *Bingham* 540.

Extracts from reports upon the Armstrong guns and sights of batteries of field artillery in Canada, *App.* 464, 465.

Carriage Department (*Woolwich*). There have been several complaints about the gun carriages issued from Woolwich, but they have not been of much importance, *Bingham* 358.

Very few instances of carriages made at Woolwich having turned out defective, or having failed, *Clerk* 901–908——Responsibility of witness for the articles manufactured in the Carriage Department; advantage thereof, *ib.* 910–917.

Carriages (*Armstrong Guns*). Good character of the Armstrong recoil carriage, *Jerningham* 3633——Defective gear of the carriages for the 12-pounder and 40-pounder, *ib.*

Statement explanatory of the results as regards the carriages used with different Armstrong guns with which experiments were made on board the "Cambridge," &c. *App.* 322, 323.

Return from the "Excellent," dated 22 February 1859, showing the results of experiments with the Armstrong 32-pounder, with reference to the question of the carriages being suitable for naval purposes, *App.* 408. 417–420——Conclusion from the foregoing trials that the carriage worked well, but that it is complicated in its structure, and altogether unfit for between decks, *ib.* 408.

Particulars of trials in November 1859 with an Armstrong 32-pounder and 70-pounder on board the "Wrangler;" modifications required in the carriages, *App.* 420–422.

Sundry experiments with carriages for Armstrong guns at sea, as carried out on board the "Excellent," between July 1860 and the end of 1861, showing in detail the action of the different carriages, and the defects requiring amendment, *App.* 424–446.

Particulars of trials, in June and July 1860, of boats' carriages for Armstrong guns, fitted for non-recoil, *App.* 424, 425——Results of experiment, in October 1860, with boat carriage for the Armstrong 12-pounders, in which the recoil is received upon india rubber buffers, *ib.* 428, 429——Results of trials of naval carriage for the Armstrong 40-pounder, as carried out on board the "Excellent," in November 1860, *ib.* 429-431.

Particulars of trial, in December 1860, of the naval slide carriage for the Armstrong 40-pounder, *App.* 431——Results of experiments, in December 1860 and December 1861, as regards the carriages used for the 100-pounder gun at sea, *ib.* 432.

Statement of experiments, in January 1861, with the 25-pounder Armstrong gun when used as a boat's gun, as regards the working of the carriages, &c., *App.* 433——Particulars of trials, in September and October 1861, of the carriage for the 20-pounder Armstrong gun, as a broadside gun for vessels of a certain class, *ib.* 443, 444.

Total expenditure of 210,182 *l.* 17 *s.* in the Royal Carriage Department, up to 31 March 1863, in connexion with Armstrong guns, *App.* 480.

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CAST-IRON GUNS:

1. *Failure of Guns strengthened and rifled by Mr. Whitworth and Sir W. Armstrong.*
2. *Evidence in approval of the Abandonment of the Experiments with Cast-iron Guns.*
3. *Views of Captains Scott and Blakely as to the Efficiency of these Guns if properly strengthened.*

1. *Failure of Guns strengthened and rifled by Mr. Whitworth and Sir W. Armstrong:*

Bursting of the cast-iron guns rifled by witness in 1858, and consequent intimation from Government that no more guns were to be rifled on his principle, *Whitworth* 2469–2477. 2528–2544——Success obtained by some cast-iron rifled guns when low charges and short projectiles have been used, *ib.* 2481–2484.

Pressing circumstances under which cast-iron guns were hooped and rifled in 1860; failure of these guns, although the experiment was justifiable, *Sir W. G. Armstrong* 3228——Failure of the cast-iron guns rifled on the shunt principle, *Scott* 4357–4361.

Explanation as to the faulty character of Sir W. Armstrong's experiments in 1859 and 1860 for strengthening cast-iron guns with wrought-iron hoops; circumstance of witness having at the time prognosticated the failure of these guns, *Blakely* 4735–4738 4744. 4755——Costly character of the experiments in hooping cast-iron guns, *ib.* 4738.

Abandonment of the attempt to apply the shunt principle to cast-iron guns, *Duke of Somerset* 5100——Reference to the experiments with a view to strengthening and rifling cast-iron guns, the result being, at the end of 1860, that Mr. Bashley Britten's gun was the most enduring, *Baring* 5233.

Return of strengthened cast-iron guns which have been tested in experiments under the Ordnance Select Committee, since the year 1858, showing the way in which each gun was strengthened, the number of rounds fired before the bursting of the guns, &c., *App.* 546, 547.

2. *Evidence in approval of the Abandonment of the Experiments with Cast-iron Guns:*

Decided condemnation of the alternative of rifled cast-iron guns, *Sir W. G. Armstrong* 3227, 3228——Opinion that it is perfectly out of the question to accomplish anything against iron plates by hooping and rifling cast-iron guns, *ib.* 3228.

Reference to the abandonment of attempts to rifle cast-iron guns; approval thereof, *Duke of Somerset* 5100, 5101——Communication from the Admiralty to the War Department in November 1860, declining to receive any rifled cast-iron guns for the navy, *Baring* 5233, 5234.

Careful and extensive experiments, with respect to the strengthening of cast-iron guns, before the Armstrong guns were finally and completely adopted, *Rep.* v.

3. *Views of Captains Scott and Blakely as to the efficiency of these Guns, if properly strengthened:*

Statement relative to the part taken by witness in advocating the rifling of the cast-iron guns in the service, and conclusion as to the strengthening and rifling of these guns not having been tried under the conditions necessary to ensure success, *Scott* 4275–4295 ——It has been tried to strengthen the cast-iron guns with brass and with wrought-iron, but not with steel, *ib.* 4292.

Exceptions to the conclusions upon the subject of rifling arrived at by the Committee appointed by Lord Herbert to consider the best mode of making the cast guns available; the trial by this Committee of witness's gun, as a rifled gun, was not satisfactory to him, *Scott* 4296–4310——With regard to witness's views in 1859 upon the question of rifling cast-iron guns, his chief object was to render available the existing supplies of ammunition, *ib.* 4311——Further experiments now being made with a view to strengthening cast-iron guns, *ib.*

Good prospect of success held out by some cast-iron cylinders, rifled on various systems, *Scott* 4473, 4474——Witness does not, however, advocate any attempt to return to the material of cast-iron for rifled guns, *ib.* 4524, 4525.

Reference to an offer by witness during the Crimean War to strengthen the naval guns in the Black Sea, &c.; this could have been done locally, *Blakely* 4690. 4861, 4862—— Steps taken by Government in 1857 for strengthening some cast-iron guns with wrought-iron rings, in order to test the strength of witness's plan; considerable amount of endurance arrived at, *ib.* 4694–4698. 4730–4734——Belief that a cast-iron gun properly hooped with wrought-iron, or rather with steel, would be perfectly efficient; grounds for this conclusion, *ib.* 4699 *et seq.*

Opinion as to the expediency of strengthening with wrought-iron or steel the cast-iron guns now in the service, that is, unless it be decided to have large guns altogether, on account of the 32-pounder and 68-pounder not possessing sufficient penetrating power,

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CAST-IRON GUNS—continued.

3. *Views of Captains Scott and Blakely, &c.*—continued.

Blakely 4699–4708——Statement showing that in Spain cast-iron guns hooped with steel and rifled, have proved exceedingly durable, *ib.* 4715–4718. 4725–4728——Further statement as to the probable endurance of hooped cast-iron guns, that is, if hooped on witness's principle and not on that of Sir W. Armstrong, *ib.* 4724–4745——Much greater endurance of an old gun strengthened by witness than of one strengthened by Sir W. Armstrong, against which it was tried, *ib.* 4744. 4755.

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Charge of Powder (*Armstrong and Whitworth Guns*). Much smaller charge of powder used for the Armstrong large gun than for the Whitworth guns, *Sir W. Wiseman* 200–207. 218–220.

Expediency of a gun being made so strong that it can consume what powder can be put into it, *Whitworth* 1535. 2009. 2015–2019. 2029, 2030——Statement as to the charge of powder and weight of projectile used with witness's four ton gun and the service four ton gun; denied that the latter has any advantage hereon, *ib.* 2007 *et seq.*

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Charleston. Illustration at Charleston of the powerful character of guns made on witness's plan, *Blakely* 4766–4769. 4834, 4835.

Chinese War. Cause of the damaged state of the Armstrong ammunition sent to China, *Sir W. Wiseman* 272, 273——Slight character of the defects in the Armstrong guns sent to China: alterations since made in them, *Anderson* 759–765——In China the Armstrong gun answered very well, but it had not had a severe trial there, *Sir R. Dacres* 2228–2230.

Particulars as to the exceedingly satisfactory operation of witness's gun during the China war, *Sir W. G. Armstrong* 3166, 3167. 3328——The experience in China shows that rifled guns can be used with great effect at distances far exceeding the range of smooth-bore guns, *ib.* 3166, 3167——Valuable operation of the new system in bringing the China war to a speedy termination, *ib.* 3266——Those officers who, in China and elsewhere, have had the largest experience with the guns, are almost unanimous in their approval of them, *ib.* 3884.

Circumstance of the officers who commanded batteries in the late operations in China having found no difficulty in keeping them in order in all weathers and under all circumstances, *Rep.* vii.

Cleaning (*Armstrong Guns*). Practice at Shoeburyness not even to clean the guns after firing, that is, when used from day to day, *Sir W. G. Armstrong* 3228.

Report, in January 1862, upon the improved cleaning rods for the Armstrong guns, as tried on board the "Excellent;" their efficiency under certain conditions, *App.* 447.

Report, in February 1862, upon Captain Lyon's improved cleaning rods for the Armstrong guns: their advantages, *App.* 447.

Satisfactory result of an experiment in order to test the efficacy of Colonel Boxer's lubricator, independently of the application of the sponge during practice, *App.* 449, 450.

Report, in September 1862, of the trial of a scraper, proposed by Colonel Boxer, for the purpose of scraping the chamber of the 110-pounder, and preventing the accumulation of hard deposit, *App.* 454.

See also *Lubrication.* *Sponges.* *Wads.*

Clerk, Lieutenant Colonel Henry. (Analysis of his Evidence).—Very few instances of carriages made at Woolwich having turned out defective or having failed, 901–908——Report made by witness in 1860, as to the excessive weight of some 10-inch shells issued for land service, 909——Responsibility of witness for the articles manufactured in the Carriage Department: advantage thereof, 910–917——Importance of the heads of the several departments at Woolwich being responsible for the inspection, rather than of having an independent inspection over all, 912–926——Advantage of the manufacture of guns being inspected by an artillery officer, 918–925.

Coast Defences. Witness strongly objects to the use of coiled wrought-iron, with reference more especially to the very large guns required for coast defences, *Blakely* 4607–4609.

Coating of Armstrong Projectiles. Advantage of the soft substance or coating on the projectile when used in the Armstrong muzzle-loader, *Gardner* 89–91. 98——Occasional stripping of the lead coating from the shot used on board the "Warrior;" improvements have, however, been made in the coating, *Cochrane* 2236. 2288, 2289——Serious defect of the Armstrong ammunition on account of the stripping of the lead coating, *Seymour* 2300.

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Coating of Armstrong Projectiles—continued.

Important advantage of witness's plan for the use of projectiles with a thin covering of lead, in conjunction with muzzle-loading, *Sir W. G. Armstrong* 3164, 3165——Statement as to the lead not having stripped off during an extended firing in the China war, *ib.* 3228. 3265, 3266——Great exaggeration and delusion which have prevailed on the subject of the stripping of the lead from the projectile, *ib.* 3265-3266——The use of a soft-coated projectile is one essential part of the system, *ib.* 3497-3499.

Rare instances lately on board the "Excellent" of the lead coating stripping off the projectile, *Hewlett* 3297——Advantage of lead-coated projectiles, and of the shot rather than the gun bearing any strain, *ib.* 3320. 3338. 3395-3413——Great advantage of the Armstrong projectile as compared with the Whitworth projectile on account of the lead coating, *Jerningham* 3712, 3713——Objection to coating spherical shot with lead, *ib.* 3719.

Statement that whilst the lead sometimes stripped off the shot on account of the method in which in which it was formerly attached, this does not now occur, *Sir W. G. Armstrong* 3892-3897——Belief that no corrosion or deterioration of the lead coating now takes place, *ib.* 3898——Less friction of the soft metal used in witness's system than of the hard metal used in the polygonal system, further contended for; diagrams referred to in corroboration of this conclusion, *ib.* 3935-3941. 3949.

Statements by Capt. Jerningham and other officers of the results as regards the projectiles of Armstrong guns with which experiments were carried on in the "Cambridge;" conclusion that there is no serious danger with respect to the stripping off of the lead coating, *App.* 325.

Report by the Ordnance Select Committee in January 1862 with respect to the system of coating the projectiles with lead, and the relative advantages of the method of zinc solder and of undercut grooves, *App.* 364-367.

Satisfactory result of certain steps in order to ascertain whether the shot of the 40-pounder gun became injured by knocking about the deck, *App.* 457.

Return of practice with Armstrong guns from Garden Island, Port Jackson, on 4th March 1862, showing that the leading of the projectile stripped off in three instances, *App.* 470.

Coating of the projectiles with soft metal adverted to by the Committee as one of the peculiarities of the Armstrong system, *Rep.* iv.

Cochrane, Captain Arthur, R. N. (Analysis of his Evidence.)—Commands the "Warrior," 2231——One-fourth of the armament of the "Warrior" consists of Armstrong guns, which witness considers a very good proportion, 2232-2235. 2249. 2275, 2276——Advantages of the Armstrong gun on the score of accuracy and range, 2236. 2246-2248. 2285, 2286——Defect of the gun on account of the accidents arising from the vent-piece, 2236. 2262-2268. 2278, 2279——Very dense smoke arising from the peculiar powder used with the Armstrong gun, and serious inconvenience thereby, 2236. 2240. 2254-2258. 2290.

Drawback on account of the guns being incapable of ricochet firing, 2236——Defect consequent upon the use of a slow-burning powder, 2236. 2282-2284——Deflection of the Armstrong shot to the right after striking the water, 2236. 2238, 2239. 2285-2287. 2292-2295——More damaging effect at short range of the 68-pounder than of the Armstrong 110-pounder against iron-plated ships, 2237——Effect of the practice in the "Warrior" upon the character of the flaws in the guns, 2241-2243——Prejudicial increase in the recoil of the 110-pounder if the charge of powder be increased to 14 lbs., 2244. 2249.

Interval between the rear of the shot and the cartridge, and increased recoil in consequence, 2244. 2269-2272——Somewhat less rapidity and precision of firing with the 68-pounder than the 110-pounder, 2245-2247——Several objections to breech-loaders as compared with muzzle-loaders; approval however of a certain proportion of rifled breech-loaders, 2262-2277——Improbability of the Armstrong gun bursting, 2280, 2281——Increased strain upon the gun if the ordinary powder were used, 2282-2284.

Coil System:

1. *Use of Coils in some Guns of Mr. Whitworth; denial by him that the principle is anything new.*
2. *System of Coils or Hoops involved in Captain Blakely's Guns; claim by him in regard to Sir W. Armstrong's Patent.*
3. *Explanatory statement by Sir W. Armstrong; disclaimer of any imitation of the Blakely Gun.*
4. *Objections to the principle of Coil Manufacture.*

1. *Use*

Report, 1863—*continued.*

Coil System—continued.

1. *Use of Coils in some Guns of Mr. Whitworth; denial by him that the principle is anything new:*

Statement in letter from witness to the "Times" in November last that the coil principle of the Armstrong gun had been adopted in this country some years ago, and that witness himself had used coils in 1855, *Whitworth* 1130——Reference to the circumstance of coils having been used in witness's gun made at Woolwich, *ib.* 1195-1199——Statement as to the coil principle having been used in fowling-pieces for some years, and as to witness having described the process in his patent of 1854, *ib.* 1204-1213.

Explanation that witness's patent of 1854 did not contemplate the same system of coils or hoops adopted by Sir W. Armstrong; distinct character of the process of making the hoop on the principle of coils, *Whitworth* 1265-1285——Examination upon the question of witness having made a gun in 1855 with hoops of welded coiled iron; explanation that this gun was not finished, *ib.* 1286-1307. 1327, 1328. 1347-1358——Instances subsequently to 1855 of witness having made guns of coiled iron welded, *ib.* 1308-1311.

Distinction between the Armstrong gun and witness's gun that the tubes of the former are composed of welded iron on the coil principle whilst witness has always used an inner tube made from a solid bar, not coiled, *Whitworth* 1311-1319——Further statement that the coil principle is not new, and has been used for years for fowling-pieces, *ib.* 1320-1326. 2596.

Explanation as to the mode of construction of the hoops used for the guns made by Mr. Whitworth in 1855 and subsequently; respect in which the construction was different from that adopted for the Armstrong guns, *Hulse* 1359-1384.

Letter from Messrs. Whitworth & Co. to the War Department, dated 2d May 1861, with reference to the failure of homogeneous metal as used in a gun supplied by them, and requesting to be supplied from the Royal Gun Factory with two barrels, made on the coiled system, in a rough bored and turned state, *App.* 397.

Copy of letter from Mr. Whitworth, dated 15th May 1861, requesting that two coiled barrels for 70-pounder guns may be supplied to him from Woolwich, *App.* 458.

2. *System of Coils or Hoops involved in Captain Blakely's Guns; claim by him in regard to Sir W. Armstrong's Patent:*

Statement as to witness having submitted to the authorities a gun upon the coil system, but not a rifled gun, *Blakely* 4622-4625——Identity between the system of coiling applied to guns made for witness in 1855, and the system at the Arsenal, *ib.* 4627. 4675-4678——Patent taken out by witness in February 1855, involving the principle of construction subsequently carried out by Sir W Armstrong; communications between witness and him on the subject, *ib.* 4628-4642. 4659.

Sir William Armstrong never gave any description of his system to witness in 1854 or 1855, *Blakely* 4632-3637——Witness could not tell one of Sir William Armstrong's guns from his own, *ib.* 4639——Absence of similarity between witness's system and the invention of Mr. Treadwheel in regard to the welding of the coils, *ib.* 4643-4645——The real essence of the Armstrong gun and of witness's gun does not lie in the use of the coils, but in the manner in which the outer coils are made to compress the inner ones, *ib.* 4645. 4649.

Reference to a correspondence in 1859 between witness and the War Office, relative to the alleged infringement of his patent, *Blakely* 4646-4649. 4662-4664——Statement showing the views of Sir William Armstrong in elucidation of his plan of construction, *ib.* 4649——Conclusion arrived at by the Ordnance Select Committee in 1855, in regard to the principle of building the Armstrong rifled gun being somewhat similar to that proposed by witness, *ib.* 4657. 4659.

Explanation as to witness having, in 1859, commenced proceedings against the Elswick Company, and as to his having abandoned the proceedings in consequence of the communication going on at the time with Government upon the same subject, *Blakely* 4665-4670——Witness was advised that an action would not hold against Government, the Armstrong patent having become their property, *ib.* 4670, 4671.

With regard to the first gun made by Sir William Armstrong, that is, in 1854, the principle of construction was arrived at altogether independently of witness, *Blakely* 4677, 4678——Witness patented merely the making a strong barrel, *ib.* 4679-4681——It was in 1854 that witness first brought his plan before the Government, the patent having been taken out in 1855, *ib.* 4689, 4690——He first tendered the gun to Government, and had no idea of a patent until it became necessary in his arrangements with the manufacturers, *ib.*——The first gun made by witness strictly on the coil principle was in 1859, but he made guns on an analogous principle in 1855, *ib.* 5410-5412.

3. *Explanatory Statement by Sir W. Armstrong; Disclaimer of any Imitation of the Blakely Gun:*

Peculiarity of witness's gun, as made in 1855, in being mainly composed by coiling spirally long bars of iron into tubes, and welding them upon the edges, *Sir W. G.*

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Coil System—continued.

3. *Explanatory Statement by Sir W. Armstrong, &c.*—continued.

Armstrong 3163——Denial that hydraulic presses had ever been made upon the coil principle as applied by witness, *ib.*——There was nothing original in the built-up character of the gun, *ib.*——Great difficulty experienced by witness in perfecting the application of coil principle, although it may now appear easy enough to define how the coils are to be made, *ib.*

Conviction that in the absence of a proper kind of steel, coiled barrels of wrought iron are the best alternative, *Sir W. G. Armstrong* 3163——Witness has from the first adhered to the principle of coiled iron tubes, and has applied it alike to three-pounders and to 600-pounders, *ib.*——Illustration of the great strength and endurance of guns made on this principle, *ib.*——Use made of the coil principle by all inventors in rifling, desirous of constructing a gun that will resist the highest possible charge, *ib.* 3163.

The system of construction of guns obtained in return for the public outlay may be described shortly as the coil system, the same being applicable either to a steel barrel or to a coiled barrel, *Sir W. G. Armstrong* 3487–3495.

Examination relative to the points of similarity between the system of Captain Blakely and of witness; entire disclaimer by witness of any infringement of Captain Blakely's patent, or any imitation of his system, *Sir W. G. Armstrong* 5002–5009.

4. *Objections to the principle of Coil Manufacture:*

The principle of construction of the Armstrong guns is, in witness's opinion, utterly wrong, *Whitworth* 1451——Witness would never think of building up a gun so small as a 6-pounder or 12-pounder, *ib.* 1464——Objections made by witness in 1860 and 1861 against the principle of coil manufacture, *Scott* 4311.

For very large guns the system of coiled wrought-iron is very undesirable, *Blakely* 4607–4609——Object of the coil system to get welds of wrought-iron round the gun in that form the least mischievous, *ib.* 4626——Opinion as to the coil system being now superseded by a better method of making hoops or cylinders, that is, out of cast-steel, hammered and annealed, *ib.* 4685——Witness attributes the strength of the Armstrong gun, not to the coils but to the method of putting the tension on the outer parts of the gun, *ib.* 4686–4688.

Reference to a certain drawing, submitted by witness to the Committee, as having been prepared in 1860, in order to illustrate the defects of the coil system; explanation to this effect, *Blakely* 5403–5415——Liability of a gun made entirely on the coil system to blow its muzzle out or to break at a blow, *ib.* 5413–5415.

See also *Durability or Endurance.* *Expenditure.* *Experiments.* *Patent (Armstrong Guns).* *Seven-inch Whitworth Gun.* *Welded Metal.*

Coles, Captain Cowper, R. N. (Analysis of his Evidence.)—Unsatisfactory result of some experimental firing with two 40-pounder Armstrong guns on board the "Trusty"; several vent-pieces were broken, disabling for a time each of the guns, 1554–1564. 1602–1608——Inconvenience experienced in the experimental firing of two 110-pounder Armstrongs on board the "Hazard"; no vent-pieces were broken, 1565–1568——Objection to the Armstrong gun for naval purposes, not only on account of the liability of the vent-pieces to break, but on account of the complicated character of the gun as a breech-loader, 1569–1581. 1601–1610. 1619–1643.

Advantage of smooth-bore muzzle-loaders over rifled breech-loaders for close fighting at sea, especially against iron ships, 1576. 1583–1585. 1611–1613. 1619, 1620. 1633–1640——Probability of the Armstrong guns being the best rifled guns that we could have adopted, 1582–1600. 1614–1618——For long range fighting, and as chase guns, there should be some rifled guns in each ship, 1585–1587. 1637–1640.

Important advantages of muzzle-loaders, so that a rifled muzzle-loader is much wanted, 1620–1622——Very heavy gun contemplated by witness in connexion with his cupola system, 1623–1629——Opinion as to our 68-pounder gun being as efficient as the Dahlgren gun, 1650–1659——Advantage respectively of the flat-headed and spherical projectile, 1660–1667.

Compensation (Elswick Company). See *Elswick Company*, 1. 8.

Competition. A proper competition should have been secured before such an enormous outlay was incurred, *Richards* 4057, 4058. 4081, 4082; *Scott* 4195–4216——Advantages promised by the guns of Mr. Bashley Britten and Mr. Jeffrey, whereas they were never tried under the same conditions as the Armstrong gun, *Scott* 4168–4172. 4217–4249——Experiments now about to be made with the guns of Mr. Britten, Mr. Jeffrey, Mr. Lancaster, and also with witness's gun, *ib.* 4250, 4251.

The competition preparatory to the introduction of the Armstrong gun should have been generally made known, *Blakely* 4621——Statement as to witness having in 1860, and subsequently, repeatedly applied to Government for leave to compete for the production of rifled guns, but without success, *ib.* 4746–4748——Expediency of the system of

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Competition—continued.

of different inventions rather than individual guns, having in the first instance been tested against each other before so enormous an expenditure was incurred, *Blakely* 4894, 4895. 4898–4904. 4913–4922.

Objection mainly to the Armstrong system having been carried out so extensively and at such an enormous subsequent cost, without proper opportunities having been given to other inventors to bring forward their plans, and without satisfactory experiments having been carried out, *Blakely* 4916–4922.

When the Estimates in 1861 were made, there was no gun before the War Office which could be put at all in competition with the Armstrong gun, *Baring* 5230–5234.

See also *Experiments. Inventors. Ordnance Select Committee.*

Concentric Tubes. System of construction involved in the manufacture of Captain Blakely's guns, that is, by building up cannons in concentric tubes, the outer ones compressing the inner ones, *App.* 534–536. 548–550.

Condemnation of Defective Guns. Expediency of all guns which show any deficiency after proof being condemned altogether, *Bingham* 421–423.

See also *Lined Guns. Obsolete Patterns.*

Confederate Army. Reference to the excellent results produced by witness's guns in America, *Blakely* 4766–4769. 4834–4838——Circumstance of the Confederate cavalry being armed with field guns made by witness, and firing concussion shells, *ib.* 4839, 4840.

Contract Supplies. Circumstance of cast-iron guns having been made for Government under the superintendence of a military officer, *Sir W. G. Armstrong* 3518–3524.

Decision by the Secretary of State in 1860, that all stores supplied by the trade of the country shall be inspected by officers specially appointed for that duty by the War Department, the contractor being under no responsibility to the Government for articles once accepted, *App.* 397.

See also *Competition. Elswick Company. Experiments. Inventors.*

Cost. See *Expenditure. Prices or Cost.*

Cross-filing. Practice of cross-filing the iron used in the Armstrong guns, with a view of rendering it uniformly tough, *Anderson* 693–696.

Cupola Ships. Much more rapid firing from a gun in a cupola on board the "Trusty" than from a broadside gun, *Coles* 1555–1559——Very heavy gun contemplated by witness in connexion with his cupola system, *ib.* 1623–1629.

Advantage of breech-loaders in turreted ships, *Earl of Lauderdale* 2161.

Particulars of trials in February and March 1862, of Captain Coles' shield, fitted to contain two 100-pounder Armstrong guns, in order to ascertain whether the guns could be worked satisfactorily; favourable results obtained, *App.* 447–449——Further trial of Captain Coles' model of shield for two 100-pounders, showing the amount of recoil under different circumstances, *ib.* 451.

D.

Dacres, Major General Sir Richard, K. C. B. (Analysis of his Evidence.)—With regard to the Horse Artillery, the commanding officer has reported to witness that out of sixty-five Armstrong 9-pounders, only ten are considered really effective, on account of the flaws, 2173. 2182, 2183——Immense practice in the Crimea with the 68-pounders, and other smooth-bore guns, and very favourable result thereof, 2174–2180——Entire change to the Armstrong gun of the armament of the Field Artillery, 2181——Opinion that the Armstrong gun is the best rifled gun known, but that it has many defects, 2184–2189. 2204.

Limited extent to which it is desirable to rely upon the Armstrong gun for field batteries, 2185–2200——Complicated character of the gun, so that there should be a skilled artificer in every Armstrong battery, 2186. 2190–2192. 2217–2223——Great importance of the ricochet, which is a drawback of the rifled gun, 2186, 2187. 2196–2199——Obstacle to the use of rifled guns of very large calibre for garrison purposes, 2188, 2189——Favourable opinion entertained by witness of Mr. Bashley Britten's gun, or rather of his shot, 2201, 2202.

Serious objections to a breech-loader as compared with a muzzle-loader, on account of the liability of the vent-pieces, &c., to give way, 2203——Cause of the rapid wearing out of the Whitworth brass guns sent to Shorncliffe, 2205–2209——Difficulty on account of the fuze for the Armstrong shell being so unreliable, 2225–2227——Excellent character of the Boxer fuze used in the Crimea, 2227——In China the Armstrong gun answered very well, but it had not a severe trial there, 2228–2230.

Dacres, Rear Admiral Sydney. (Analysis of his Evidence.)—Commanding in Chief of

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Dacres, Rear Admiral Sydney. (Analysis of his Evidence)—continued.

the Channel Fleet; has had several opportunities of observing the practice with the Armstrong gun, 3168-3173——Approval of the proportion of eight Armstrong guns on board 80-gun ships, or one in ten, 3174, 3175. 3204——Peculiar destructiveness of the Armstrong shell against wooden ships, 3176——Difficulty of depending upon the Armstrong gun at sea, when there is much motion, 3177-3181——Occurrence of several accidents on board men-of-war, in connexion with the vent-piece, 3182-3190 —— Uncertainty of the richochet of elongated rifled shot at sea, 3191——Removal of a gun from the "Queen," on its being discovered that there were flaws in it, 3192-3195. 3216, 3217.

Objection to larger guns than 100-pounders on board men-of-war, 3196, 3197—— Witness strongly approves of some rifled guns for ships of war, and would prefer muzzle-loaders to breech-loaders if they could be rendered equally durable, which he doubts, 3198-3215——Opinion that the Whitworth guns will not last, 3198-3200—— Very favourable opinion entertained by French naval officers of the French rifled guns, 3205, 3206——Improbability of naval actions being decided at long ranges, 3218-3220 ——Doubt as to breech-loading being particularly objectionable at night quarters, except in so far as the vent-piece is likely to give way, 3221-3224.

Dahlgren Gun. Opinion as to our 68-pounder smooth-bore gun being as efficient as the Dahlgren gun, *Coles* 1650-1659.

De Grey and Ripon, Earl. (Analysis of his Evidence.)—Was Under-Secretary of State for War for some time previous to the death of Sir Cornewall Lewis; is now Secretary of State, 5019-5021——Arrangement as regards the plant of the Elswick Company, that a portion of it may be taken by Government at a certain price, the rest remaining the property of the Company, 5022-5024—— Obligation upon the Government, in carrying out the arrangement, to be bound by the original agreement between General Peel and the Elswick Company, 5025.

Explanation as to the valuer appointed by Government having disputed a sum of 20,009 *l.* claimed on the part of the Company for depreciation, 5026-5031——Total of 65,535 *l.* 4 *s.* as the amount agreed upon by the valuers to be paid to the Company, independently of the item in dispute as regards depreciation; this sum was ordered by Sir Cornewall Lewis to be paid, 5031——Arrangement subsequently as regards the item for depreciation, that Government should pay 19,464 *l.* 16 *s.* receiving in return stores and plant; opinion as to full value having been received for this payment, 5031-5036. 5039-5041.

Statement as to witness, in entering upon and carrying out the negociation, having been bound by the original agreement and by the award of the valuers, 5037, 5038. 5042 ——Expectation of witness that so large a sum as 65,000 *l.* would not have been awarded by the valuers, 5038. 5042——Witness does not say that if there had been no agreement he could have made a better arrangement, 5042——Reference to the peculiar circumstances under which the original agreement was made with the Elswick Company; witness does not impugn the action of General Peel in the matter, 5043. 5092.

With regard to the introduction of the larger Armstrong guns for the navy, this was not decided upon till after General Peel had left office, 5044-5049. 5059, 5060. 5065, 5066——Increase of the guarantee to the Elswick Company by Lord Herbert, in whose time the larger guns were adopted, 5044-5049——Heavy pressure both for naval and military guns, so that the factories at Elswick and Woolwich were, for some time, kept fully employed, 5050. 5088-5090——Large outlay necessary at Woolwich in order to have supplied all the guns from the factory there, 5051, 5052. 5061.

Intention at the War Office, before the appointment of the present Committee, to put a stop to the agreement with the Elswick Company, on account of not being able to keep it in full work, 5053. 5090, 5091——Facilities in the first instance at Elswick but not at Woolwich for making the guns, 5054-5058——Until Government had entered into a special agreement with Sir W. Armstrong, they merely stood in the same light towards him as towards an ordinary manufacturer or inventor, 5061-5063.

Reference to the steps taken by General Peel for establishing a small separate factory at Woolwich, as a check upon the Elswick prices; the first guns supplied from Woolwich were made at this factory, 5064. 5082-5084——Government could not have manufactured the guns without the patent; with it they can prevent manufacture by any one else, 5068-5074——It is provided by Act that the patent may be kept secret, and witness considers it unadvisable to produce it, 5075-5081——The agreement with the Elswick Company might have been terminated at any time by paying the amount guaranteed under it, 5085-5087.

Defects (Armstrong Guns). See *Failures and Defects.*

Deflection of Armstrong Projectiles. Deflection of the Armstrong shot to the right after striking the water, *Cochrane* 2236. 2238, 2239. 2285-2287. 2292-2295.

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Director of Ordnance. Limited information which witness is in a position to give with reference to Krupp's guns, or the question as to the use of steel or homogenous metal; his functions as Director of Ordnance adverted to hereon, *Tulloh* 2735–2778. 2848–2855.

Distribution of Metal (*Armstrong and Whitworth Guns*). Inaccuracy of a statement by the Ordnance Select Committee that the metal in witness's 7-inch gun is not differently distributed from that of the service guns, *Whitworth* 1177–1182——Conclusion as to the different and more equal distribution of the metal in the Whitworth 7-inch gun as compared with the Armstrong 7-inch gun ; reference hereon to the great difference in their relative weights, and in the charge of powder and weight of shot, *Hulse* 1516–1550——There is a considerable difference between the Whitworth and Armstrong 7-inch guns in the distribution of the metal, *Anderson* 1767. 1770–1779.

Durability or Endurance:

1. *Armstrong Guns.*
2. *Blakely Guns.*
3. *Whitworth Guns.*

1. *Armstrong Guns:*

Doubt as to the Armstrong rifled guns being so much more durable than smooth-bored guns, as has been stated, *Gardner* 66–70——Great durability of the Armstrong or polygroove gun, with a lead-coated projectile, *Sir W. Wiseman* 191. 222–229——Improbability of the Armstrong gun bursting, *Cochrane* 2280, 2281.

Illustration of the great strength, endurance, and safety of the guns made upon witness's principle of coiled iron tubes, *Sir W. G. Armstrong* 3163——Illustration of the great endurance of the unlined field guns on witness's principle, *ib.* 3253, 3254——Instance of a 12-pounder having been fired 3,263 rounds, and being still perfectly good and serviceable, *ib.* 3253.

Opinion as to the great endurance of the Armstrong guns, *Jerningham* 3639–3641. 3745–3147.——Conclusion arrived at by the Admiralty as to the enduring power of the Armstrong 100-pounder, in consequence of the tests applied and satisfactorily withstood, *Scott* 4436–4438——Strength of the Armstrong gun attributed to the method of putting the tension on the outer parts of the gun, *Blakely* 4686–4688.

Advantage of the method of construction, as first proposed by Mr. Armstrong, by which the gun is rendered capable of enduring the strain to which rifled ordnance is submitted, *Rep.* iv.——Reference to the statement that none of the Armstrong guns, on the coil principle, have burst explosively, or have failed except by a gradual process, *ib.* vii.

2. *Blakely Guns:*

Great endurance of a 9-pounder smooth-bore gun made for witness by the Butterley Company, *Blakely* 4690–4693.

Results of a comparative trial of strength made by order of the Ordnance Select Committee in 1855–56, between a cast-iron service gun, a brass service gun, and one of Captain Blakely's built-up guns, all 9-pounders; very severe test of the latter gun, and great endurance and strength exhibited by it, *App.* 533.

3. *Whitworth Guns:*

Exception taken to the statement before the Ordnance Select Committee, that the quick rifling turn adopted by witness strains the gun excessively, *Whitworth* 2000–2005——Belief that some of witness's guns have been in actual service and have done well, *ib.* 2031–2033——Very small wear of witness's guns, *ib.* 2466——Confidence of witness in the enduring power of the guns now being made by him; test to which subjected, *ib.* 2977–2988——Belief as to the present good condition of a 12-pounder gun now at Shoeburyness, delivered by witness in 1860, *ib.* 2994, 2995——Expediency of further official trials with a view to determine the most enduring kind of ordnance, *ib.* 3033.

Grounds for the opinion that the Whitworth guns will not last, *Admiral Dacres* 3198–3200——Doubt as to the Whitworth gun being safe or durable on account of the tendency of the shot to get jammed in the bore, *Hewlett* 3309–3317. 3336–3338. 3344–3346. 3395–3416.

See also *Brass Guns.* *Steel, or Homogeneous Metal.*

E.

Eighty-pounder Whitworth Gun. Result of experiments in January 1861, on board the "Stork," at Spithead, from a Whitworth 80-pounder breech-loading gun, in order to test its suitableness both as a breech and muzzle-loading naval gun, *App.* 434, 435.

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ELSWICK COMPANY:

1. *As to the Original Agreement with the Elswick Company, and the Guarantees given by Government.*
2. *Withdrawal of Sir W. Armstrong from the Company.*
3. *Obstacle to obtaining the required Supplies of Guns from Woolwich.*
4. *Cost or Price respectively at Elswick and at the Royal Gun Factory.*
5. *Total Payments and Liabilities to the Company.*
6. *Total supplies of Guns from Elswick.*
7. *Reason for procuring Projectiles from Elswick; calculated Saving if made at the Royal Laboratory.*
8. *As to the Termination of the Agreement, and the Amount of Compensation paid to the Company.*

1. *As to the Original Agreement with the Elswick Company, and the Guarantees given by Government:*

Accuracy of a certain outline (as given by General Peel) of the proceedings between the War Office and witness at the end of 1858, in regard to the conditions of a supply of guns from Elswick, *Sir W. G. Armstrong* 4923–4938——Demand on the part of the Admiralty for a 70-pounder gun which led, in February 1859, to an extension of guarantee from 35,000 *l* to 50,000 *l.*, *ib.* 4959–4962——Subsequent guarantee to the extent of 30,000 *l.* in respect of projectiles to be made at Elswick, making a total guarantee of 80,000 *l.*, *ib.* 4968–4970——The machinery and buildings at Elswick cost about 180,000 *l.*, *ib.* 4973. 4983.

Reference to the peculiar circumstances under which the original agreement was made with the Elswick Company; witness does not impugn the action of General Peel in the matter, *Earl De Grey and Ripon* 5043. 5092——Increase of the guarantee to the Elswick Company by Lord Herbert, in whose time the larger guns were adopted, *ib.* 5044–5049——The agreement with the Elswick Company was in operation when Lord Herbert came into office, *ib.* 5052——Until Government had entered into a special agreement with Sir William Armstrong, they merely stood in the same light towards him as towards an ordinary manufacturer or inventor, *ib.* 5061–5063——The agreement with the Elswick Company might have been terminated at any time, by paying the amount guaranteed under it, *ib.* 5085–5087.

Correspondence between Sir W. Armstrong and the War Office, in April and October 1859, relative to the guarantees to be given to the Elswick Company in respect of the provision of special machinery for guns and projectiles, *App.* 509, 510.

Reference by the Committee to the circumstances under which arrangements were first entered into with the Elswick Company, whilst they were guaranteed against loss by the erection of buildings and machinery to the amount finally of 85,000 *l.*, *Rep.* iv, v——Taking all the circumstances into consideration, the Committee are unprepared to impugn the wisdom of the course adopted by General Peel, and followed by succeeding administrations, with respect to the Elswick Company, *ib.* vi.

2. *Withdrawal of Sir W. Armstrong from the Company:*

Statement as to witness having withdrawn from the Elswick Company when it became apparent that he was to assume an official position, *Sir W. Armstrong* 4958.

3. *Obstacle to obtaining the required Supplies of Guns from Woolwich.*

Impossibility, early in 1859, of obtaining the guns from Woolwich, or from any other source than Elswick, *Sir W. G. Armstrong* 4963–4967——Pressure of orders, both at the Gun Factory and at Elswick, in 1860 and 1861, so that the number supplied from Elswick could not have been provided at the Gun Factory, unless there had been a large additional expenditure on plant, &c., to the extent probably of 120,000 *l.*, *ib.* 4971–4983. 4986–4990. 4992. 4997–5001.

Heavy pressure both for naval and military guns, so that the factories at Elswick and Woolwich were for some time kept fully employed, *Earl De Grey and Ripon* 5050. 5088–5099——Facilities in the first instance at Elswick, but not at Woolwich, for making the guns, *ib.* 5054–5058.

4. *Cost or Price respectively at Elswick and at the Royal Gun Factory:*

Witness has prepared certain statements and calculations showing the sums paid to the Elswick Company for guns and projectiles, as compared with the cost if supplied by the Royal Gun Factory, *Whiffin* 3073–3077——From one of these statements it appears, that with respect to the sum of 593,275 *l.*, part of the amount paid to the Elswick Company, there would have been a saving of about 242,173 *l.* if the articles had been manufactured at the Gun Factory; accuracy of this result, *ib.* 3077.

Much higher price which would have been demanded for the first guns produced, but for the guarantee that the contractors should not be losers by the erection of the plant and machinery, *Sir W. G. Armstrong* 4939–4948——Saving of considerably more than the first

Report, 1863—*continued.*

ELSWICK COMPANY—continued.

4. *Cost or Price respectively at Elswick, &c.*—continued.

first guarantee of 35,000 *l.* by the reduced prices actually charged for the 180 guns ordered in January 1859, *Sir W. G. Armstrong* 4949-4957—— There was never any reference to witness in regard to the Elswick prices, or the distribution of orders, *ib.* 5013, 5014.

Estimates in 1861 for the prices or cost of the several classes of guns at Woolwich and at Elswick, *Baring* 5247——For the larger guns made at Elswick the original agreement as to prices was provisional, *ib.* 5250——Willingness expressed by the Company to modify the price in the course of manufacture if the guns came out quicker, *ib.*—— So far as witness can judge the Elswick Company have behaved very fairly with regard to the price, *ib.* 5250. 5261.

Check invariably exercised through the heads of departments at Woolwich in regard to the Elswick prices, *Baring* 5252-5267——Sir W. Armstrong did not interfere in any way with the prices, *ib.* 5253, 5254. 5258——Provision that in the case of difference with the Elswick Company there should be a reference as to prices to the Attorney General, *ib.* 5256, 5257——Instances of the prices of the Company having been reduced by the War Office, *ib.* 5258, 5259——Instances also of the prices first agreed upon having been reduced by the Company themselves, as the manufacture became more perfected, *ib.* 5260, 5261.

Enhanced cost of the guns first produced both at Elswick and at Woolwich on account of the experimental character of the manufacture, *Baring* 5261——Statement as to the wholesome check exercised by the operation, and the prices of the Elswick Company upon the manufacture at Woolwich, *ib.* 5261-5272——Opinion that the prices paid to the Elswick Company have not been excessive, allowance being made for the amount to be added as profit, *ib.* 5283-5291. 5295.

Exceptions taken to certain calculations by Mr. Whiffin, tending to show that an immense saving might have been effected if all the guns and projectiles had been made at Woolwich, *Baring* 5315-5327——Unfairness generally of comparing the prices at Elswick during the experimental stage with the prices at Woolwich after the experimental stage, *ib.* 5316-5326.

Doubt as to there having been much expenditure at Elswick in experiments, after the adoption of the Armstrong gun, *Anderson* 5494-5500——Evidence to the effect that the competition of Elswick has been beneficial as regards the Gun Factory, although without reference to it witness has always worked at his best, *ib.* 5503-5514——Some improvements in the gun have been made at Elswick, at the expense of the Elswick Company, *ib.* 5566-5568.

Further statement as to the accuracy of the general result of witness's calculations, showing for 1861–62, a total of 242,000 *l.* in favour of Woolwich as compared with Elswick, if all the guns had been made at the former place, *Whiffin* 5585-5597.

Statement showing the amount and rates paid for certain guns to the Elswick Ordnance Company, compared with the original rates assumed in Sir W. G. Armstrong's letters, printed in the Appendix to the Report from the Select Committee on Ordnance, in 1862 (*p.* 252), *App.* 466——Explanation by the Assistant-Accountant General that the prices assumed by Sir W. Armstrong in 1858 were for 200 guns only, and were merely approximate, *ib.*——Great difference between the actual rates paid and the rates assumed in the letters from Sir W. Armstrong in 1858, the former being only about half the amount of the latter, *ib.* 467.

Statement showing the cost of certain guns obtained from the Elswick Ordnance Company, compared with the rates of those produced at the Royal Arsenal, Woolwich, *App.* 480-482.

Letter from the Elswick Ordnance Company to the Chairman of the Committee, dated 16 June 1863, in order to controvert the statement made by Mr. Whiffin relative to the cost of guns made at Elswick and at Woolwich, and the saving calculated by him if the whole of the guns had been made at Woolwich, *App.* 539-541——Further letter from the Elswick Company, dated 4th July 1863, together with tabular statements relative to the general expenses and capital charges in the Royal Gun Factories, *ib.* 542-544.

Communication from Mr. Whiffin, dated 6 July 1863, dissenting from the statements made on the part of the Elswick Company, in the letter of 16 June, and contending for the fairness of the calculations as to the cost at the Gun Factory, *App.* 555-558.

Reference by the Committee to the conflicting evidence upon the question of the comparative cost at Elswick and at Woolwich; difficulty in arriving at any satisfactory conclusion on this subject, *Rep.* vi.

5. *Total payments and Liabilities to the Company:*

The gross payments made to the Company, after deducting the amount for compensation, is 965,117 *l.*, *Whiffin* 3077.

ELSWICK COMPANY—continued.

5. *Total Payments and Liabilities to the Company*—continued.

Total of 1,035,412 *l.* 17*s.* 7*d.* paid to the Elswick Company from March 1858 to 6 May 1863, including 70,295 *l.* 8*s.* paid on account of compensation for termination of contract, *App.* 480.

Statement showing the payments to the Elswick Ordnance Company on account of Armstrong guns and projectiles, and all material connected therewith, in each year since their introduction into the service, including all experimental guns and ammunition, *App.* 482. 585.

Total of 965,117 *l.* 9*s.* 7*d.* paid to the Elswick Company for articles supplied, *Rep.* v. ——Total of 65,534 *l.* 4*s.* paid to the Company as compensation, after giving credit for the value of plant and stores received, *ib.*——Total of 37,143 *l.* 2*s.* 10*d.* as the amount of the outstanding liabilities to the Company for articles ordered, *ib.*

6. *Total supplies of Guns from Elswick:*

Return showing the total number and nature of Armstrong guns manufactured and supplied by the Elswick Ordnance Company up to the 31 March 1863; aggregate of 1,137, less 157 outstanding, *App.* 379.

7. *Reason for procuring Projectiles from Elswick: Calculated Saving if made at the Royal Arsenal:*

Doubt as to the capabilities of the Royal Laboratory for producing the projectiles made at Elswick, *Sir W. G. Armstrong*, 4984, 4985. 4991——Reason for the projectiles not having been made originally at Woolwich, as was contemplated at first, *ib.* 4993–4996.

Statement as to the Armstrong projectiles not having in the first instance been made at the Laboratory, on account of the arrangement that Sir W. Armstrong was to have the controul of the manufacture, *Baring* 5273. 5276–5282——Whilst the Estimates for 1861 were under consideration it was stated by Colonel Boxer that he could make the projectiles much cheaper than they were made for at Elswick, *ib.* 5273——Excess of expenditure in 1861 beyond the estimated cost of the supply of projectiles from Elswick, *ib.* 5274, 5275——Higher prices of ammunition and projectiles at Elswick than at the Arsenal adverted to as largely explained by experimental and small orders in the former case as compared with the latter, *ib.* 5318–5326.

Probable enhancement of the Elswick prices for ammunition by reason of the earlier manufacture and smaller orders than at Woolwich, *Whiffin* 5648–5652.

Statement showing the entire willingness of witness to have carried out any instructions for manufacturing ammunition and projectiles for the Armstrong gun, *Boxer*, 5708. 5710. 5740–5748——In order to fix the responsibility on Sir W. Armstrong it was considered necessary to place the arrangements under his superintendence; this was also his own request, *ib.* 5709. 5737, 5738.

With an additional outlay of about 1,000 *l.* on machinery witness could have made in the Royal Laboratory all the fuzes and shells supplied from Elswick and Woolwich, *Boxer* 5714. 5719, 5720—— Facilities for cheaper manufacture from the first at the Laboratory than at Elswick, *ib.* 5715. 5723——There had been more experience at the Laboratory than at Elswick in manufacturing projectiles, so that they could have been made cheaper from the first, *ib.* 5715.

Conviction as to the accuracy of the calculations and accounts of the cost of producduction at the Laboratory; large public saving if all the projectiles had been made there, instead of some having been made at Elswick, *Boxer* 5716–5719——Effect of the competition of the two establishments to reduce the cost at Elswick but not at the Laboratory, *ib.* 5721–5723.

Statement that there would have been no difficulty in the first instance in carrying out the manufacture in the Laboratory under the superintendence of Sir W. Armstrong; reference herein to an exception taken by Sir W. Armstrong, in 1861, to the mode in which witness was making some projectiles, *Boxer* 5739–5748.

Statement showing the cost of projectiles and of fuzes obtained from the Elswick Ordnance Company compared with the rates of those produced at the Royal Arsenal, Woolwich, *App.* 481, 482.

Statement of cost of ammunition, &c., for Armstrong guns made in the Royal Laboratory and at Elswick up to 31st March 1863, *App.* 585.

8. *As to the Termination of the Agreement, and the Amount of Compensation paid to the Company.*

Arrangement as regards the plant of the Elswick Company, that a portion of it may be taken by Government at a certain price, the rest remaining the property of the Company, *Earl De Grey and Ripon*, 5022–5024——Obligation upon the Government, in carrying out the arrangement, to be bound by the original agreement between General Peel and the Elswick

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ELSWICK COMPANY—continued.

8. *As to the Termination of the Agreement, &c.*—continued.

Elswick Company, *Earl De Grey and Ripon* 5025——Explanation as to the valuer appointed by Government having disputed a sum of 20,000 *l.* claimed on the part of the Company for depreciation, *ib.* 5026–5031.

Total of 65,535 *l.* 4 *s.* as the amount agreed upon by the valuers, to be paid to the Company independently of the item in dispute as regards depreciation; this sum was ordered by Sir Cornewall Lewis to be paid, *Earl De Grey and Ripon* 5031——Arrangement subsequently as regards the item for depreciation, that Government should pay 19,464 *l.* 16 *s.*, receiving in return stores and plant; opinion as to full value having been received for this payment, *ib.* 5031–5034. 5039–5041——Statement as to witness, in entering upon and carrying out the negotiation, having been bound by the original agreement and by the award of the valuers, *ib.* 5037, 5038. 5042.

Expectation of witness that so large a sum as 65,000 *l.* would not have been awarded by the valuers, *Earl De Grey and Ripon* 5038. 5042——Witness does not say that if there had been no agreement he could have made a better arrangement, *ib.* 5042——Intention at the War Office, before the appointment of the present Committee, to put a stop to the agreement with the Elswick Company, on account of not being able to keep it in full work, *ib.* 5053. 5090, 5091.

Consideration of the charge in the Elswick accounts in respect of depreciation; conclusion as to this charge having reference to the plant and not to the orders or cost of the guns, *Baring* 5347–5349. 5372–5374. 5389–5393. 5399–5401——Advantage to Government if, instead of paying 65,000 *l.* for compensation, they had become possessed of plant in return for such expenditure, *Anderson* 5542–5547.

Appointment of Mr. Thomas Elliott Harrison as valuer for the Company, in the matter of the termination of the Elswick contract, and for the compensation to be paid to the Company, *App* 491——Appointment of Mr. James Nasmyth as umpire, in the event of difference between the valuer for the Company and for the Crown, *ib.* 492.

Schedule showing in detail the machinery at the Elswick works in respect of which compensation is to be paid, and showing also the other items of expenditure, &c. upon which the claim for compensation arises, *App.* 492–506——Summary of claims under different heads; aggregate of 85,544 *l.* 4 *s.*, *ib.* 506——Assent by the valuer to the sum of 85,544 *l.* 4 *s.* as the amount due to the Company, it being left an open question whether deduction is to be made on account of previous depreciation of machinery, *ib.*

Memorandum of agreement made on 29th April 1863, between the War Department and the Elswick Company, showing the conditions finally agreed upon as to the sum to be paid to the Company, and as to the transfer of certain machinery to the Government, *App.* 507–509.

Correspondence between the Elswick Company and the War Department in 1862 and 1863, with reference to the discontinuance of orders to the Company, the application by the latter for compensation, and the arrangements eventually concluded on the subject, *App.* 511–519

Termination of the agreement with the Elswick Company in April 1863, 85,000 *l.* having been paid to them for compensation, whilst stores and plant of the estimated value of 19,000 *l.* have been received from them, *Rep.* v.

See also *Accounts* (*Woolwich Departments*). *Expenditure.* *Gun Factory.*

Endurance of Guns. See *Durability or Endurance.*

Engineer for Rifled Ordnance. Witness was, until recently, Superintendent of the Royal Gun Factory, having been originally Engineer for Rifled Ordnance; his duties under each appointment were substantially the same, and were mainly of an engineering character, *Sir W. G. Armstrong* 3157–3162.

Advantage to Sir W. Armstrong in his being present at trials with guns of other inventors, *Richards* 4053–4062——Probable prejudice to other inventors by reason of the official position of Sir W. Armstrong as Engineer for Rifled Ordnance, *Scott* 4252–4275. 4311; *Blakely* 4773–4795. 4874–4880. 4892–4894

Definition of Sir W. G. Armstrong's duties as "Engineer for Rifled Ordnance," and terms of his appointment, as laid down in a memorandum, dated War Office, 23d February 1859, *App.* 486.

Reference to the resignation by Sir W. Armstrong in February 1863, of his appointment as Engineer of Rifled Ordnance &c., so that he has ceased to be an officer of the Government, *Rep.* v.

Ewart, Captain Charles.—(Analysis of his Evidence). Has been Captain of the "Cambridge" for about 2½ months, 4532, 4533.——Previously commanded the "Melpomene" for four years, her armament comprising five 110-pounder Armstrong's, and eight 40-pounders, out of thirty-five guns in all, 4534–4542.——Excellent practice with the Armstrong guns in close harbour at 2,600 yards, 4543.——Practice also at long ranges

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Ewart, Captain Charles. (Analysis of his Evidence)—*continued.*

out at sea, the ship rolling much at the time, and the firing not being accurate, 4544-4548.——Sufficient accuracy of the smooth-bore gun up to 1,000 yards at sea, 4546. 4548.

Occurrence of only one accident, that of the splitting of a vent-piece, in all witness's practice with the Armstrong guns, 4548. 4589——Preference for the smooth-bore gun over the rifled breech-loader or muzzle-loader, for quick firing at close quarters, that is, on account of the complicated character of the latter, 4549. 4564-4568. 4570-4583.——The slowness of the projectile in leaving the Armstrong gun is not an objection of any moment, 4550, 4551.——Probable inconvenience in close action from the way in which the lubricating wad is screwed on, 4552——Thickness of the smoke adverted to, 4553.

Opinion that one Armstrong gun in five is as much as there should be on board a man-of-war, 4554, 4555. 4569.——Reference to the character of the guns and projectiles in Fortress Monroe, 4558-4561.——Although the Armstrong guns are too complicated for quick firing in close action, they are very desirable as chase guns, and for bombarding at a distance, 4570. 4577. 4588.——The 68-pounder smooth-bore is the best gun at close quarters, and future actions are likely to be settled at close distances, 4573-4576. 4579-4583.

Absence of apprehension on board the "Melpomene" through fear of accidents with the Armstrong gun, 4589-4592.——Risk incurred respectively by iron and wooden ships in passing by a battery of Armstrong guns, at 1,000 yards, 4594-4598.——Great danger to an iron-plated vessel if penetrated by a shell, 4599-4603.

"*Excellent,*" *H.M.S.* Return from Her Majesty's Ship "Excellent" of trials of rifled ordnance since 1st January 1858, showing in detail the working of, and the results obtained, by Armstrong and Whitworth guns, and projectiles of different natures, *App.* 408 *et seq.*——Copies from first experiment book, commencing 22d December 1857, *ib.* 408-422.——Copies from second experiment book, commencing 5th July 1860, *ib.* 423-452——Copies from third experiment book, commencing 4th September 1862, *ib.* 452-457.

EXPENDITURE (ARMSTRONG GUNS, &c.):

1. *Evidence in defence, and approval of the outlay incurred.*
2. *Evidence to a contrary purport.*
3. *Statistics of Expenditure at Elswick and Woolwich.*

1. *Evidence in defence and approval of the outlay incurred:*

Conclusion that the original adoption of the Armstrong guns (as for field service), and the expenditure involved therein, were perfectly justifiable, *Duke of Cambridge* 1232-1234. 1248-1252.

Statement in support of the conclusion, that no other alternative was open to Government, than to incur the expenditure involved in the adoption of the system designed by witness, *Sir W. G. Armstrong* 3227, 3228——The real question for the present Committee to determine is, whether the system adopted in 1858 was, at that time, the best available system, *ib.* 3228——Reiteration of the conviction that the expenditure on rifled ordnance has been simply compensated for by the advantages obtained, *ib.* 3266——Unrivalled character of the combined system of guns and ammunition obtained in return for the public expenditure; if rival there be, witness knows not where it is to be found, *ib.*

Opinion that the public expenditure on the Armstrong gun was wisely incurred, *Hewlett* 3353, 3354. 3415-3417. 3434-3436.

Witness does not look upon the patent possessed by Government as any return for the expenditure incurred, which is rather to be measured by the actual working of the system, *Sir W. G. Armstrong*, 5010-5012.

Notwithstanding the enormous expenditure incurred, the experiments and the results obtained have been well worth their cost, *Duke of Somerset* 5219-5228——On the whole, witness considers that the course taken by the War Office with reference to the Armstrong gun was the best under the circumstances, *ib.* 5226-5228.

Statement to the effect, that at the time of deciding in 1861 upon the expenditure in 1861-62 upon Armstrong guns, there were no other guns to be put in competition against them, *Baring* 5230-5234.

2. *Evidence to a contrary purport:*

With regard to the question as to the propriety of so large an expenditure on Armstrong guns, witness considers that too large a number of 110-pounders were made whilst the vent-pieces were yet unsatisfactory, *Jerningham* 3656-3679. 3686-3689. 3794——The great expenditure on the larger Armstrong guns was hardly justifiable, their efficiency not having been properly proved by experience, *Wainwright* 3811, 3812.

Opinion that a proper competition should have been secured, with a view to the adoption of a more perfect weapon, before ordering supplies of Armstrong guns to the amount

Report, 1863—*continued.*

EXPENDITURE (ARMSTRONG GUNS, &c.)—continued.

2. *Evidence to a contrary purport*—continued.

amount of 2,500,000 *l.*, *Richards* 4057, 4058. 4081, 4082——Reference to the circumstance of the French Government having been content with rifling brass and cast-iron guns, whilst an immense outlay was incurred by the country in order to have an entirely new gun, *ib.* 4088–4101.

Witness considers that the expenditure in the Armstrong naval gun was not wisely incurred, and adduces grounds for this conclusion, *Scott* 4114 *et seq.*——Disapproval expressed by witness on more occasions than one, of the continuous and expensive manufacture of Armstrong guns, although a limited supply of them was doubtless justifiable, *ib.* 4311.

Witness disapproves of the Armstrong breech-loading system, and considers that its defects might have been ascertained with much less expenditure than has taken place, *Blakely* 4607——Enormous expenditure incurred without the production of any gun, in general use in the navy, sufficiently powerful to operate against iron-clad ships, *ib.* 4607–4609——Offer made by witness in November 1860, to supply guns at a lower rate than the Elswick Company; its refusal on the ground of experiments then pending, *ib.* 4762. 4771, 4772.

Expediency of the systems of different inventors, rather than individual guns, having in the first instance been tested against each other, before so enormous an expenditure was incurred, *Blakley* 4894, 4895. 4898–4904. 4913–4922——Objection mainly that the Armstrong system has been carried out so extensively, and at such an enormous subsequent cost, without proper opportunities having been given to other inventors to bring forward their plans, and without satisfactory experiments having been carried out, *ib.* 4916–4922.

3. *Statistics of Expenditure at Elswick and Woolwich:*

Return of the sums paid for guns, shells, and fuzes, complained of by the Artillery Committee; net estimate of 140,000 *l.*, *App.* 462.

Statement showing the amount and rates paid for certain guns to the Elswick Ordnance Company, compared with the original rates assumed by Sir W. G. Armstrong's letters (as printed in the Appendix to the Report from the Select Committee on Ordnance in 1862, *p.* 252); *App.* 466——Explanation by the Assistant Accountant General that the prices assumed by Sir W. Armstrong in 1858, were for 200 guns only, and were merely approximate, *ib.*——Great difference between the actual rates paid and the rates assumed in the letters from Sir W. Armstrong in 1858, the former being only about half the amount of the latter, *ib.* 467.

Statement showing, under different heads, the total amount that has been expended, and the amount of liabilities in existing orders, &c., so far as the same can be ascertained, in the manufacture of guns and projectiles on Sir William Armstrong's principle, *App.* 480——Statement showing the cost of guns and projectiles as obtained from the Elswick Ordnance Company, compared with the rates of those produced at the Royal Arsenal, Woolwich, *ib.* 480–482.

Statement of cost of ammunition, &c., for Armstrong guns, made in the Royal Laboratory, and at Elswick, up to 31st March 1863, *App.* 585.

Total of 1,067,794 *l.* 16 *s.* 5 *d.* as the aggregate amount of the payments and liabilities in respect of guns and projectiles from Elswick, *Rep.* v——Total expenditure of 1,471,753 *l.* 1 *s.* 3 *d.*, in the three manufacturing departments at Woolwich, on the Armstrong guns, ammunition, and carriages, *ib.*——Grand total of 2,539,547 *l.* 17 *s.* 8 *d.* in respect of the Armstrong guns and projectiles at Elswick and at Woolwich, *ib.*

See also *Accounts* (*Woolwich Departments*). *Armstrong Guns.* *Cast-iron Guns.* *Competition.* *Experiments.* *Field Guns.* *Fuzes.* *Gun Factory.* *Lined Guns* (12-*pounders.*) *Navy, The.* *Projectiles or Shells.* *Whitworth Guns and Projectiles.*

EXPERIMENTS:

1. *Official Explanations relative to the Experiments before the adoption of the Armstrong Gun.*
2. *Representations and Complaints by Mr. Whitworth.*
3. *Objections raised by Mr. Westley Richards, with suggestions for an amended System of Experiments.*
4. *Exceptions taken by Captain Scott to the course pursued.*
5. *Representations and Complaints by Captain Blakely.*
6. *Sundry Returns and Reports explanatory of the Experiments with the Armstrong, Whitworth, and other Guns.*
7. *Further Experiments about to be made.*
8. *Conclusions and Recommendations of the Committee.*

Report, 1863—*continued.*

EXPERIMENTS—continued.

1. *Official Explanations relative to the Experiments before the adoption of the Armstrong Gun:*

In consequence of former experiments the Ordnance Select Committee, of which with ness was a member, concluded that further detailed experiments were advisable only in the case of the guns of Mr. Armstrong and Mr. Whitworth, *Sir W. Wiseman* 122–124. 133–135. 265——Large number of experiments carried out by the Committee, between the Armstrong and Whitworth guns, *ib.* 125, 126——Explanations as to the Committee not having visited Mr. Whitworth's manufactory, *ib.* 127, 145–147——Inadequate means afforded to the Committee for properly testing the merits of the Whitworth guns, on account chiefly of the great difficulty in obtaining ammunition, *ib.* 127–130. 132. 136–144, 266——Nature of the experiments made before arriving at the conclusion that the Armstrong gun was the best for field service, *ib.* 131. 265–268.

Alteration in the Whitworth shell since the time of the experiments, *Sir W. Wiseman* 141, 142——Inaccuracy of statements that Mr. Whitworth was unfairly dealt with by the Ordnance Select Committee, and that necessary facilities were not afforded to him as to Mr. Armstrong, *ib.* 145–150. 154–156——The experiments were chiefly carried on with the 18-pounder, *ib.* 158.

Less trial of the Whitworth guns than of the Armstrong guns, owing very much to difficulties raised by Mr. Whitworth, *His Royal Highness The Duke of Cambridge* 1239–1241.

Witness was secretary to the Committee on Rifled Ordnance, which decided upon the introduction of the Armstrong gun into the service, and was present at all the trials up to a certain date, *Noble* 3079, 3080——The Whitworth gun was tried eight or nine times, and the Armstrong gun about 50 times, *ib.* 3081–3085——Mr. Whitworth was present at trials when diagrams of his gun were made, *ib.* 3086–3090. 3133——Due notice of the trials of his gun was always given to Mr. Whitworth, and he was afforded every facility to be present; in point of fact, he was present at nearly all the trials, *ib.* 3087–3104. 3126–3131, 3133——The records of the Committee would not show upon which occasions Mr. Whitworth was present, or that previous notice was given to him, *ib.* 3091–3095.

The Committee rigidly adhered to the rule that no inventor should be present at the trial of another inventor's gun, *Noble* 3098——The reason Mr. Whitworth's gun did not receive the same extended trial as the Armstrong gun was, that he only provided shot and common shell without fuzes, whereas Sir W. Armstrong had a perfect fuze and Shrapnell shell, *ib.* 3105–3115——At this period Mr. Whitworth had not a gun of his own construction, but had merely rifled Government blocks of brass and cast-iron, *ib.* 3105——Fuzes might in time have been prepared by Government for the Whitworth shell, with a view to a more perfect trial, but it was not the province of a Committee on Rifled Ordnance to undertake this matter, *ib.* 3106–3115. 3122–3125.

No programme of the proceedings of the Committee was ever furnished to any competitor, *Noble* 3131——The guns were fired and worked entirely by artillerymen, *ib.*——Explanation upon the question of one shot with the Whitworth gun which fell very short of the range having been included in the calculations; propriety thereof, *ib.* 3134–3137.

Reference to the number and size of experimental guns of different kinds made upon witness's principle at Woolwich and at Elswick, *Sir W. G. Armstrong* 3885–3891.

General Peel is in no way accountable for the experiments in the case of the larger guns, *Earl De Grey and Ripon* 5059, 5060——Various satisfactory reports relative to the Armstrong gun which were before the War Department in framing the Ordnance Estimates in 1861, *Baring* 5230——Moreover, at this period there was no gun before the War Office which could be put at all in competition with the Armstrong gun, *ib.* 5230–5234.

Communication from the War Office, dated 8th September 1858, relative to the appointment of Colonel Mitchell and other officers as a Special Committee for investigating the subject of Rifled Ordnance, *App.* 399.

Communications between Mr. Whitworth and Captain Noble in November 1858, relative to experiments with the Whitworth 32-pounder, *App.* 401.

Proceedings and Report of the Special Committee ordered in 1858 to inquire into the Expenses incurred by Mr. Whitworth in carrying out Experiments on behalf of the Government; suggestions by the Committee that certain further experiments be made, at an estimated cost of between 5,000 *l.* and 6,000 *l.*, *App.* 524, 525.

2. *Representations and Complaints by Mr. Whitworth:*

Statement to the effect that witness has not been paid for the experiments with rifled ordnance, which he undertook at the request of Lord Hardinge; he has received 15,885 *l.* for experiments with rifled gun barrels, and 4,735 *l.*, for what he has supplied as an ordnance manufacturer, but is 10,278 *l.* out of pocket by his experiments with ordnance, *Whitworth* 1411–1445——Witness never saw the official report upon the experiments

EXPERIMENTS—continued.

2. *Representations and Complaints by Mr. Whitworth*—continued.

experiments made with his gun at Southport in 1860, but has reason to believe it was favourable, *Whitworth* 2354, 2355. 2488.

Exception taken to the evidence of Sir W. Wiseman, as to great difficulty having been experienced by the Ordnance Select Committee in obtaining ammunition from witness when first testing his gun, *Whitworth* 2365 *et seq.*——Supply by witness of shot and hollow shell, which were sufficient for testing the range and accuracy, without his having supplied any fuze for the shell; examination on this latter point, *ib.* 2366–2415. 2504–2511. 2552–2562. 2577–2581——No opportunity was given to witness to be present at the comparative trial of his gun and the Armstrong gun, nor was he aware of such trial before the adoption of the latter, *ib.* 2416–2418. 2426.

Circumstance of the gun submitted by witness for trial having been a Government gun, rifled on his principle, whilst the gun of Sir W. Armstrong was not only rifled, but was originated by him, *Whitworth* 2419–2432——Date of the first complete gun supplied by witness; it was a 70-pounder breech-loading gun with a homogeneous tube and wrought-iron noop, *ib.* 2423–2428——Inaccurate results obtained as to the shooting of witness's 12-pounder at the trial on the 2d April 1861, witness not having been present to correct or protest against the error, *ib.* 2433–2444——Bursting of different guns rifled by witness adverted to; his 5½ gun made of homogeneous metal did not however burst, although the inner tube was cracked, *ib.* 2469–2477. 2582–2592.

Admission by witness as to his having been in error in assuming that Sir W. Wiseman was a member of the Ordnance Select Committee in 1858, when a programme of the trials to be made with the two guns was previously submitted to Sir W. Armstrong, *Whitworth* 2512–2527——With regard to the reputed failure of the battery supplied by witness to Shorncliffe, the trial to which these guns have been subjected is of a very exceptional character, *ib.* 2571–2576——Circumstance of Shrapnel shells for experiments with witness's gun, having, upon application, been made by Colonel Boxer, and having answered very well; this was long subsequent to the experiments in 1858, *ib.* 3025–3029.

Consideration of the grounds of witness's complaint that he had not an opportunity of being present at the trials between his gun and the Armstrong gun; he was present at several trials of his own gun, and cannot say that both guns were ever tried at the same time, *Whitworth* 3034–3063——Witness's gun was not sufficiently tried at all, *ib.* 3046. 3058, 3089. 3063——Sir W. Armstrong was not present when witness's gun was tried, *ib.* 3057——Inaccuracy of certain diagrams of witness's system, as supplied by Sir W. Wiseman, *ib.* 3070–3072.

3. *Objections raised by Mr. Westley Richards, with Suggestions for an Amended System of Experiments:*

Witness considers that the Committee which recommended the adoption of the Armstrong gun did not make a sufficient number of comparative trials with other guns, and that the guns compared should have been identical in every respect, save the system of rifling, *Richards* 3970–3990. 4026. 4030. 4063–4074. 4103–4107——The Armstrong guns and Whitworth guns were so different in regard to weight, charge of powder, &c., that no fair deduction could be drawn in favour of any one system of rifling, *ib.* 3970–3977. 3982.

Nature of the conditions which might be imposed by Government, in order to secure competitive guns tried under identical circumstances, *Richards* 3975–3990. 4030——Improvement if the experiments with rifled ordnance might be attended by any scientific persons taking an interest in the matter, *ib.* 3991–3993. 4079, 4080——Statement as to witness having been refused permission to be present at a trial between the Armstrong and other guns; he was not aware of a rule excluding inventors from attending experiments with the guns of other inventors, *ib.* 3994–4014.

Opinion that a proper competition should have been secured, with a view to the adoption of a more perfect weapon, before ordering supplies of Armstrong guns to the amount of 2,500,000 *l.*, *Richards* 4057, 4058. 4081, 4082——Approval however of the best available guns having been adopted without prolonging experiments indefinitely, *ib.* 4063–4074——Expediency of a proper series of experiments being carried out in order thoroughly to test the comparative merits of the Armstrong and other guns, *ib.* 4102.

Further suggestions by Mr. Westley Richards as to the questions to be determined by comparative experiments, that is under the several heads of rifling, powder, projectile, weight of gun, and length of bore, *App.* 531——Suggestions also as to the mode of testing the value of a gun, with reference to the proportion or per-centage of marks to be given under different heads, *ib.*—— Suggestions as to the proper mode of instituting a comparison between the Armstrong system of rifling and projectile, and the Whitworth system, that is, as to the points to be observed in the case of a 90-pounder on each system, *ib.* 532.

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EXPERIMENTS—continued.

4. *Exceptions taken by Captain Scott to the course pursued:*

Objectionable system pursued by the Ordnance Select Committee, in not having required identical conditions when trying the Armstrong and other guns, *Scott* 4117-4122——Advantages possessed by the guns of Mr. Bashley Britten and Mr. Jeffrey, whereas they were never tried under the same conditions as the Armstrong gun, *ib.* 4168-4172. 4217-4249——Expediency of further experiments having been made with the Armstrong and other guns before so large an expenditure was incurred so extensively for the navy, *ib.* 4195-4216.

Probability of the inventions of Mr. Britten and others not having been properly tested, because of a pre-determination in the authorities to make some plan of Sir W. Armstrong successful; official position of Sir W. Armstrong and functions of the Ordnance Select Committee adverted to hereon, *Scott* 4252-4275.

Further statement as to the undue facilities given to experiments with the guns of Sir W. Armstrong as compared with the guns of other inventors, *Scott* 4311——Witness contends that there have been no sufficient experiments with regard to rifling, and that they have been carried out under unequal conditions, *ib.* 4330.

5. *Representations and Complaints by Captain Blakely:*

Unduly large expenditure incurred before the experiments had been sufficiently developed, *Blakely* 4619, 4620——The competition preparatory to the introduction of the Armstrong gun should have been more generally made known, *ib.* 4621.

Failure of the first smooth-bore gun submitted by witness to the Ordnance Select Committee, *Blakely* 4693——Statement as to witness having, in 1860, and subsequently repeatedly applied to Government for leave to compete for the production of rifle guns, but without success, *ib.* 4746-4748——Expediency of the system of different inventors, rather than individual guns, having, in the first instance, been tested against each other, before so an enormous expenditure was incurred, *ib.* 4894, 4895. 4898-4904. 4913-4922.

Large public expenditure in experiments with the Armstrong and Whitworth guns, whilst all witness's experiments have been conducted at his own expense, *Blakely* 4896, 4897. 4905-4907——Objection mainly that the Armstrong system has been carried out so extensively, and at such an enormous subsequent cost, without proper opportunities having been given to other inventors to bring forward their plans, and without satisfactory experiments having been carried out, *ib.* 4916-4922.

6. *Sundry Returns and Reports explanatory of the Experiments with the Armstrong, Whitworth, and other Guns:*

Return from Her Majesty's ship "Cambridge" of the experimental firing from on board that vessel, &c., with Armstrong guns of different size, showing the results of the practice and the different defects or accidents produced in the guns, *App.* 309-319.

Return showing the total number of experimental guns made in the Royal Gun Factory, respectively for Mr. Whitworth, the Ordnance Select Committee, Sir W. Armstrong, and Mr. Westley Richards, *App.* 381.

Abstract of correspondence between Mr. Whitworth and the War Office from 1854 to 1860, on the subject connected with small arms and large ordnance; together with a detail of portion of the expenses on account of those experiments, referred to in Return, at page 283 of the Committee on Ordnance, dated July 1862, amounting to 11,291*l.* 7*s.* 1*d.*, *App.* 382-393.

Return from Her Majesty's ship "Excellent" of trials of rifled ordnance since 1 January 1858, showing in detail the working of, and the results obtained by, Armstrong and Whitworth guns and projectiles of different natures, *App.* 408 *et seq.*——Copies from First Experiment Book, commencing 22d December 1857, *ib.* 408-422 —— Copies from Second Experiment Book, commencing 5th July 1860, *ib.* 423-452 —— Copies from Third Experiment Book, commencing 4th September 1862, *ib.* 452-457.

Report on experiments at Southport in 1860 with 80-pounder and 12-pounder Whitworth guns, showing in detail the results arrived at, *App.* 475-479——Recommendation in this Report that an 80-pounder and a 12-pounder be bought, and that a series of further experiments be made, *ib.* 476.

Report of experimental practice at Shoeburyness in May 1860, in order to ascertain the ranges, deflection, &c., with Commander Scott's projectiles, fired from a 32-pounder cast-iron gun, rifled on that officer's principle, *App.* 537, 538.

7. *Further Experiments about to be made:*

Impartial character of the Committee now appointed for testing the relative merits of the Armstrong and Whitworth guns, *His Royal Highness the Duke of Cambridge* 1242-1247——The process adopted by witness's firm is about to be submitted to and experimented upon

Report, 1863—*continued.*

EXPERIMENTS—continued.

7. *Further Experiments about to be made*—continued.

upon by the Ordnance Select Committee, and witness is prepared to abide by the result, *Whitworth* 3010-3012. 3064-3069——He has no doubt but his gun is now about to receive a fair trial, *ib.* 3067-3069——Experiments now about to be made with the guns of Mr. Britten, Mr. Jeffreys, Mr. Lancaster, and with witness's gun, *Scott* 4250, 4251.

8. *Conclusions and Recommendations of the Committee:*

Outline by the Committee of the circumstances connected with the first introduction of rifled ordnance; several experimental guns ordered and tried before the final adoption of the Armstrong rifled gun for field service, *Rep.* iii, iv.——Favourable report by the Ordnance Select Committee in February 1858, consequent upon the experiments between the Armstrong 18-pounder and the service 32-pounder, *ib.* iii.——Circumstances under which the first experiments with rifled guns were limited to those of Mr. Armstrong and Mr. Whitworth, *ib.* iv.——Less extended character of the experiments with the Whitworth gun than the Armstrong gun, the system proposed by Mr. Armstrong having been in fact the only complete one before the Committee appointed to try the guns, *ib.*

The Committee trust that the different systems, not of Sir W. Armstrong and Mr. Whitworth only, but of the other able men whose minds are now engaged on ordnance questions, may be fairly experimented upon, *Rep.* viii.——Unsatisfactory character of any trials to which, under proper restrictious, scientific men are not admitted, *ib.*——Nor can systems of rifling fairly compete with one another, unless the guns on which they are tried are made with equal skill, and with, in every case, the best available materials, *ib.*

See also *Cast-iron Guns.* *Competition.* *Expenditure.* *Field Guns.* *Navy, The.* *Vent-pieces*, 5. *Whitworth Guns and Projectiles.*

F.

FAILURES AND DEFECTS (ARMSTRONG GUNS):

1. *Details as to the Flaws or Defects in the Guns, and the Failures in consequence.*
2. *Explanatory Statement by Sir W. Armstrong.*

1. *Details as to the Flaws or Defects in the Guns, and the Failures in consequence:*

Serious defect on account of the numerous failures of vent-pieces, *Gardner* 8–21. 24. 72. 104——Very satisfactory result of the recent trial of twelve Armstrong guns at Shorncliffe; there was no accident whatever, *Bingham* 323–328——Satisfactory result on the whole of the trial of twelve Armstrong guns at Portsmouth; breakage, however, of one vent-piece, *ib.* 329-340——All the guns tried at Portsmouth were made in 1859, *Anderson* 572——Trifling character of the defects found in some guns at proof when first issued from the Gun Factory, *ib.* 589–592.

If the Armstrong guns are frequently fired with very heavy charges, they will probably soon show symptoms of giving way; number and character of flaws in the welding of the larger guns adverted to hereon, *Earl of Lauderdale* 2150–2158. 2161——Witness found the flaws constantly increased with the practice of the gun, *ib.* 2152, 2153——Statement as to the ineffective character of Armstrong 9-pounders issued to the artillery, on account of the flaws, *Sir R. Dacres* 2173. 2182, 2183——Effect of the practice in the "Warrior," upon the character of the flaws in the guns, *Cochrane* 2241–2243.

Guns returned to the arsenal on account of flaws will be made serviceable and again sent out, *Tulloh* 2673, 2674——The flaws or defects in the guns have not generally been of a serious kind, *ib.* 2719-2723——Doubt as to the expediency of marking so as to explain the number of flaws, whether lined, &c.; sufficiency of the written history of the gun presented to the officer in charge, *ib.* 2798–2815.

Removal of a gun from the "Queen" on its being discovered there were flaws in it, *Admiral Dacres* 3192-3195. 3216, 3217——Explanation as to four guns, out of 12, tried at Portsmouth, having been selected guns, *General St. George and Colonel Strange* 3239–3243——Unimportant character of the flaws in the Armstrong guns in the "Excellent," *Hewlett* 3292. 3376, 3377——Existence of certain flaws in the Armstrong guns under witness's charge, *Wainwright* 3787, 3788.

Statement as to witness having seen several guns at Woolwich in which the inner tubes of coiled iron were defective, *Scott* 4390-4417. 4430-4435——Occurrence of only one accident, that of the splitting of a vent-piece, in all witness's practice with the Armstrong guns, *Ewart* 4548. 4589.

Return from Her Majesty's ship "Cambridge" of the experimental firing from on board that vessel, &c., with Armstrong guns of varying natures, showing the results of the practice, and the different defects or accidents produced in the guns, *App.* 309-319

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Failures and Defects, &c.—continued.

1. *Details as to the Flaws or Defects in the Guns, &c.*—continued.

——Explanations supplied by Captain Jerningham of the several defects experienced in the firing on board the "Cambridge," *App.* 320–327.

Proceedings of a committee of artillery officers assembled at the Horse Guards on the 17th November 1862, by order of His Royal Highness Field Marshal Commanding in Chief, with the concurrence of the Right Honourable the Secretary of State for War: investigations by this committee into the question of certain reported failures and defects of Armstrong guns at Shorncliffe, Shoeburyness, &c., *App.* 328–332——Want of intelligent supervision to which are mainly attributable the accidents with vent-pieces, breech-screws, &c., *ib.* 331.

Return from Her Majesty's ship "Excellent," containing details of experiments with Armstrong and Whitworth guns since 1 January 1858, and showing the several failures or defects experienced, *App.* 408 *et seq.*

Statement, in letter, from the Armstrong gunnery instructor to the staff officer at Kirkee, as to the existence of flaws in the several 12-pounders in the Armstrong battery, examined by him, *App.* 472——Statement as to the several cracks or fissures found in six 12-pounder guns examined by a Board at Kirkee, Bombay, on 9th December 1862, *ib.* 473.

Report from the Ordnance Select Committee on the flaws discovered in six Armstrong 12-pounder guns in India; conclusion that, except in one instance, none of these flaws are of any consequence, *App.* 473–475.

List of Armstrong guns of all natures returned to Woolwich, and requiring repair in the Royal Gun Factories, up to the 3d June 1863, showing in each case the nature of the injury and the extent of the repair necessary, *App.* 529.

List of accidents reported to have happened to Armstrong guns belonging to ships in the Mediterranean, whilst Rear-Admiral Dacres was on the station, *App.* 545.

Monthly and quarterly diaries of officers commanding batteries of 9-pounder Armstrong guns, since such were first issued to the Royal Artillery, explanatory of the practice with the guns, and of their advantages and defects, *App.* 566–581.

Failure of some of the field guns adverted to by the Committee as having arisen from defective manufacture, *Rep.* vi.——Comparatively few failures of Armstrong 12-pounders, *ib.* vii.

2. *Explanatory Statement by Sir William Armstrong:*

Satisfactory firing with 12 guns at Portsmouth: doubt as to these having been specially selected, *Sir W. G. Armstrong* 3237, 3238. 3244——Very satisfactory result of the experimental firing at Dublin, which was confined to the larger guns, with improved vent pieces and breech screws, *ib.* 3244.

Undue importance attached by artillery officers to apparent defects in the welding of the guns, which look like partial openings in the coils; remarks by the Ordnance Select Committee upon this question, *Sir W. G. Armstrong* 3846–3855——Reference to the report of the Board of Survey held at Kirkee, dated 9th December 1862, upon the defects elicited in several of witness's guns; reference also to the conclusions of the Ordnance Select Committee relative to these defects, *ib.* 3847–3853——Although the original guns were much subject to flaws or bad welds, the guns now made are almost entirely exempt from that liability, *ib.* 3854, 3855.

Witness lays before the Committee a paper containing a statement of all injuries occurring to Armstrong guns of all natures which have been of sufficient importance to require the guns to be returned to the Gun Factory; inference therefrom as to the very small proportion of casualties in comparison with the extensive practice with the guns, *Sir W. G. Armstrong* 3862–3890——Number of failures of 110-pounders, 40-pounders, &c., in proving the vent-pieces, *ib.* 3881, 3882——Witness impresses upon the Committee the propriety of considering the amount of failures or defects with reference to the amount of practice; the per-centage of failure being in fact exceedingly small, *ib.* 3884.

See also *Coating of Armstrong Projectiles.* *Condemnation of Defective Guns.* *Lined Guns* (12-*Pounders*). *Vent-pieces.* *Welded Metal.*

Field Guns (12-*Pounders, &c.*):

1. *As to the Original Adoption of the Armstrong Field Gun.*
2. *Merits of these Guns considered; Experiments on the Subject.*
3. *Failures and Defects of* 12-*Pounders issued for Service.*
4. *Number supplied from Elswick and from Woolwich.*
5. *Cost at Woolwich and Elswick respectively.*
6. *Conclusions of the Committee relative to the Armstrong Field Guns.*
7. *Experiments with the Whitworth* 12-*Pounder Gun.*

Report, 1863—*continued.*

FIELD GUNS (12-*POUNDERS, &c.*)—continued.

1. *As to the Original Adoption of the Armstrong Field Gun:*

Justification of the original adoption of the Armstrong gun for field service, *Bingham* 374, 375. 524. 533-539; *H. R. H. The Duke of Cambridge* 1232-1234. 1248-1252.

Reference to a certain War Office paper as showing that witness's gun was first brought to the notice of Government in December 1854, *Sir W. G. Armstrong* 3163—— Completion of the first gun, a 3-pounder, in March 1855, it having been delivered to Government in the following July, after some experiments in the meantime, *ib.*

Probability of the expenditure upon field pieces having been judicious, *Scott* 4116—— Examination to the effect that witness objects only to the gun adopted for the Navy, and does not find fault with the Ordnance Select Committee for having recommended the smaller guns as field pieces, *ib.* 4173-4180—— Non-objection to the first expenditure for the Armstrong guns for field service, *Blakely* 4915, 4916.

During Lord Derby's Government, field guns only had been decided upon, *Earl De Grey and Ripon* 5047. 5065—— With regard to the report of the Ordnance Select Committee in which at first the Armstrong gun was strongly recommended for adoption; this referred only to the gun as a field gun, *Duke of Somerset* 5158-5162.

2. *Merits of these Guns considered; Experiments on the Subject:*

Expediency of the field gun being the simplest gun possible; opinion hereon as to the too complicated character of the Armstrong gun, *Gardner* 25. 77-80. 85-88——Reluctance of witness to give any opinion at present as to the best gun for field service, *ib.* 73-76. 81-83. 108, 109—— Very perfect character of the Armstrong guns up to 40-pounders, *Sir W. Wiseman* 292——Opinion that the Armstrong field gun, properly manufactured, is superior to any rifle gun in England or abroad, *Bingham* 374, 375. 524. 533-539—— General opinion of artillery officers as to the superiority of the Armstrong field gun, *ib.* 524.

Suggestion that, with a view to greater strength and endurance, the Armstrong 12-pounder should be made heavier, *Anderson* 723-732. 740-746.

Witness considers that the guns now in the hands of the Royal Artillery are, with present experience, as perfect as can be expected, *H. R. H. The Duke of Cambridge* 1216, 1217.

Entire change to the Armstrong gun of the armament of the field artillery, *Sir R. Dacres* 2181——Opinion as to the limited extent to which it is desirable to rely upon the Armstrong gun for field batteries, *ib.* 2185-2200——Complicated character of the gun, so that there should be a skilled artificer in every Armstrong battery, *ib.* 2186. 2190-2192. 2217-2223.

As a field gun, the Armstrong gun is superior to any yet in the service, *Tulloh* 2686, 2687——The weight of the 12-pounder is 8 cwt., that of the old 9-pounder having been 13 cwt.; approval of the former weight, *ib.* 2694. 2827-2830 ——The 12-pounder breech-loader is a very safe and good gun, *ib.* 2823.

Slight effect upon the accuracy of range of the 12-pounder by shortening it in the muzzle, *Sir W. G. Armstrong* 3852. 3862——Those officers who, in China and elsewhere, have had the largest experience with the guns, are almost unanimous in the approval of them, *ib.* 3884——The Commander in Chief and Colonel Bingham, although their confidence in the gun was shaken, have yet declared that it supplies the most efficient field artillery in the world, *ib.*

With regard to the Armstrong field-guns they are very good, but it would be a great improvement if they fired round shot and canister, *Blakely* 4841-4853——Much simpler character of the Armstrong field gun if it were a muzzle-loader, the breech being a very weak point in the gun, *ib.* 4854-4857.

Return from Her Majesty's ship "Cambridge" of the experimental firing from on board that vessel, &c. with the Armstrong 12-pounders, showing the results of the practice, and the different defects or accidents produced in the guns, *App.* 310, 311.

Explanations by Captain Jerningham of the practice with the 12-pounders, and of the defects requiring amendment in connexion with this gun, *App.* 320.

Report by Ordnance Select Committee, in August 1862, as to the necessity of sponging in the case of some 12-pounders tried at Hythe in April 1862, *App.* 339.

Results of experiments in May and June 1861, on board the "Excellent," with a shortened 12-pounder Armstrong gun, intended to form the armament of pinnaces, and also as a light field gun, *App.* 436, 437.

Reports and extracts from reports respecting the field guns sent to Canada and New Zealand; favourable results in the case of those used against the redoubts of the insurgent natives in New Zealand, *App.* 463-465.

Satisfactory report by the Ordnance Select Committee in December 1860 as to the effect of exposure to the weather on the 12-pounder Armstrong guns, *App.* 484, 485.

Report, 1863—*continued.*

Field Guns (12-*Pounders, &c.*)—continued.

3. *Failures and Defects of* 12-*Pounders issued for Service:*

Issue of seventy-seven 12-pounders made at Elswick, of which it is rumoured that three have failed in India, *Gordon* 992, 993——Explanation that of the 12-pounder guns recently reported as having failed, none of them were made at Elswick, *ib.* 1035, 1036.

Reference to the report of the Board of Survey held at Kirkee, dated 9th December 1862, upon the defects elicited in several of witness's guns; reference also to the conclusions of the Ordnance Select Committee relative to these defects, *Sir W. G. Armstrong* 3847–3853——Return of thirteen 12-pounders out of 392 issued for the land service and 178 for the service; very slight defects in some of these thirteen guns, whilst seven of them were defective owing to the mistake in having lined them, *ib.* 3862–3869——The 12-pounders which proved defective were, with one exception, all made in the first six or seven months of the manufacture, and the guns recently made have not exhibited similar defects, *ib.* 3867–3869.

Return of the number of 12-pounder Armstrong guns made in the Royal Gun Factories proved and passed; and of the number rejected by Major General Tulloh, when Inspector of Artillery (between 8th December 1859 and 7th July 1861); total of 150 guns proved and passed, and of nineteen guns rejected, *App.* 336——List of the above nineteen rejected guns, showing the dates when any of them, having been repaired, were passed into the service; with two exceptions, these guns were all lined, *ib.*

Return showing the number of Armstrong 12-pounders manufactured in the Royal Gun Factories which were passed by Colonel Tulloh whilst he was Inspector of Artillery; showing also the number and marks of identity of each gun passed, of those rejected, and of those rejected which were afterwards passed for service, with the date of their issue, *App.* 377–379——Statement of the number and cost of Armstrong 12-pounder field guns complained of by the Artillery Committee, *ib.* 462.

Letter addressed by the Armstrong gunnery instructor to the staff officer at Kirkee, with reference to the practice with Armstrong 12-pounders, and the flaws in the several guns comprising the battery, *App.* 472——Report by a Board assembled at Kirkee, on 9th December 1862, to report on a 12-pounder Armstrong gun injured at practice, as also on the other guns comprising the battery, *ib.* 473——Report from the Ordnance Select Committee, in May 1863, upon the foregoing defects; conclusion that these are not material, save in one instance, *ib.* 470–475.

4. *Number supplied from Elswick and from Woolwich:*

Total of ninety-two 12-pounder guns supplied by the Elswick Company up to 31st March 1863, including those outstanding, *App.* 379——Total of 625 12-pounders made in the Royal Gun Factory, distinguishing between the number made and issued for service, and the number made but not yet issued, *ib.* 380——Total of seventy-six 12-pounder Armstrong land service guns made at Elswick, and of 362 in the Royal Gun Factories, *ib.* 462.

Total number of Armstrong field guns issued up to February 1863, and number made respectively at Elswick and at Woolwich, *App.* 530.

5. *Cost at Woolwich and Elswick respectively:*

Experimental character of the production of 12-pounders at Elswick, so that the price was much enhanced, and was greater than the subsequent cost at Woolwich, *Baring* 5316.

Statement showing the amount and rates paid for 12-pounder guns to the Elswick Ordnance Company, compared with the original rates assumed by Sir W. G. Armstrong's letters, *App.* 466——Great difference between the actual rates paid and the rates assumed in the letters of Sir W. Armstrong in 1858, the former being only about half the amount of the latter, *ib.* 467.

Statement showing the cost of 12-pounder guns obtained from the Elswick Ordnance Company, compared with the rates of those produced at the Royal Arsenal, Woolwich, *App.* 480.

6. *Conclusions of the Committee relative to the Armstrong Field Guns:*

Outline by the Committee of the circumstances connected with the introduction of the Armstrong field guns, *Rep.* iii. iv.——Reference to the several trials and experiments which preceded the introduction of the field gun, *ib.* iii.——The Committee conclude that the adoption of the Armstrong gun for field service was fully justified, *ib.* iv.

Reference to the explanations on the subject of the defects and failures of some of the field guns; comparatively few failures, *Rep.* vi. vii.——Failure of some 12-pounders adverted to as owing to faulty manufacture, *ib.*

Reference by the Committee to the general approval of the 12-pounder, although stated by some of the witnesses to be too complicated a weapon for service, *Rep.* vi.——Conclusion that the Armstrong fieldgun is the best known for field purposes, *ib.*

On

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Field Guns (12-*Pounders, &c.*)—continued.

6. *Conclusions of the Committee relative to the Armstrong Field Guns—continued.*

On careful investigation, the Committee find that out of 570 12-pounders issued and in use, 13 only have been returned to the Royal Gun Factories for repair, three of which have proved unserviceable, and the remainder repairable at an inconsiderable expense, *Rep.* vii.

7. *Experiments with the Whitworth* 12-*pounder Gun:*

Reports from Ordnance Select Committee in 1862 on Mr. Whitworth's 12-pounder gun, &c., with reference to the question of initial velocity, *App.* 371–375——Reports, dated 17 March 1863, containing explanations relative to the present condition of the Whitworth battery of 12-pounder rifled brass guns at Shorncliffe, *ib.* 458.

Report of the experiments at Southport in 1860 with the Whitworth 12-pounder breech-loader, *ib.* 475–479.

See also *Accuracy. Ammunition. Brass Guns. Carriages* (*Armstrong Guns*). *Cast-iron Guns. Chinese War. Coil System. Durability or Endurance. Expenditure. Experiments. Failures and Defects. Lined Guns* (12-*pounders*). *Panmure, Lord. Projectiles or Shells. Range of Guns. Vent Pieces. Whitworth Guns and Projectiles.*

Fittings (*Navy Guns*). Checks have been constantly experienced by witness in his practice with the Armstrong guns on account of deficiency in some of the fittings, *Jerningham* 3626. 3723–3732——With proper care, these defects are for the most part capable of an early remedy, *ib.* 3626. 3723–3732——Room for improvement in the elevating gear and other appliances, *ib.* 3633——Suggestions made by naval officers for improvements in the gun, as in the sighting, &c. *Duke of Somerset* 5124.

See also *Carriages* (*Armstrong Guns*).

Flaws in Guns. See *Failures and Defects. Welded Metal.*

Foreign Countries. Denial that Witness's guns have been unfavourably reported upon in France, and have been rejected there, *Whitworth* 2355–2364——Witness's firm have now in hand for foreign governments about 100 guns of calibres varying from the 1-pounder to the 9-inch gun, *ib.* 2490–2497. 3002–3004——Various sizes and prices of the guns now being made by witness's firm at Manchester, *ib.* 2490–2497——Constant increase of late in witness's manufacture, so that he speaks from practical knowledge, *ib.* 3001–3006.

Large number of guns manufactured by witness for foreign governments, or made abroad according to his plan; he will supply details hereon, *Blakely* 4749–4754. 4765——Statement as to the non-adoption of the Armstrong system in foreign countries, *ib.* 4908. 4911——Statement as to the Whitworth gun having been tried in France, and having been reported against, *ib.* 4908. 4911, 4912——Belief that the gun has been adopted in Brazil, *ib.* 4911.

See also *France.*

Forts. Obstacle to the use of rifled guns of very large calibre for garrison purposes, *Sir R. Dacres* 2188, 2189.

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1. Evidence relative to the Defects of these Fuzes, their Condemnation, and the Loss incurred thereby.
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1. *Question as to the Practicability of having obtained all the Armstrong Guns from Woolwich, and as to the increased Outlay necessary for Plant.*
2. *Question as to the Saving which might have been effected if all the Guns had been made in the Government Factory.*
3. *Aggregate Number and Cost of Armstrong Guns supplied from Woolwich.*
4. *Position and Duties of Sir W. Armstrong when an Officer of the Gun Factory.*
5. *Question as to the General Superintendence and Inspection.*
6. *System of Accounts; Amendments suggested.*

1. *Question as to the Practicability of having obtained all the Armstrong Guns from Woolwich, and as to the increased Outlay necessary for Plant:*

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6. *System of Accounts: Amendments suggested:*

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Letters relative to the blowing out of the vent-piece of an Armstrong 12-pounder on board the "Harrier's" pinnace off New Zealand, whereby six of her men were wounded and two other persons were injured, *App.* 470, 471.

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Hewlett, Captain. Return from Her Majesty's ship "Excellent" of trials of rifled ordnance since 1 January 1858, showing in detail the working of, and the results obtained by Armstrong and Whitworth guns and projectiles of different natures, *App.* 408 *et seq.*

Report by Captain Hewlett, dated 4 February 1861, on the trial of Whitworth cannon on board the "Excellent," and showing several objections to the introduction of this gun into the navy, *App.* 554.

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Horse Artillery. With regard to the Horse Artillery the commanding officer at Woolwich has reported to witness that out of 65 Armstrong 9-pounders, only ten are considered really effective, on account of the flaws, *Sir R. Dacres* 2173. 2182, 2183.

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Horsfall Gun. Circumstance of the Horsfall smooth-bore gun having pierced iron plates at a distance of 800 yards; great weight of this gun, *Scott* 4163–4167.

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Hydraulic Pressure. Explanation of witness's system of placing the tubes one over the other, hydraulic pressure being employed for putting them on, *Whitworth* 3007–3009 ——Practice at Woolwich of putting on the hoops by shrinking, which is less certain in its results than hydraulic pressure, *ib.*——Immense strength by the system in which the tubes are put in by witness, *ib.* 3009.

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Improved Manufacture. Considerable improvements since 1859 in the Armstrong guns, as made in the Gun Factory, *Anderson* 567. 595. 704. 721——Rapid progress still going on in the science of artillery manufacture, *ib.* 754–756——The experience gained by witness since 1859 has been very valuable, and he can now produce better and cheaper guns, *Sir W. G. Armstrong* 3502–3506.

See also *Steel, or Homogeneous Metal.* *Vent-pieces,* 5.

Initial Velocity. Explanation on the subject of the initial velocity of witness's 12-pounder gun, as compared with the Armstrong 12-pounder, *Whitworth* 2350——Greater initial velocity with a rifled spherical shot, than with a shot not rifled, *ib.* 2457–2462.

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Initial Velocity—continued.

Statement that where the charge and the weight remain the same, the initial velocity with a rifled gun is quite equal to that with a smooth-bore gun, *Sir W. G. Armstrong* 3167.

Inferiority of the rifled breech-loader as compared with the smooth-bore, for the penetration of iron-plates, on account of the less initial velocity of the rifled gun, *Jerningham* 3646, 3647. 3694-3700——Reasons for the rifled gun retaining its initial velocity for a much longer distance than the smooth-bore, *ib.* 3695——Superior advantages of the rifled gun over the smooth-bore if it could fire with accuracy and range, not only elongated but spherical projectiles, and if a great initial velocity could be secured, *ib.* 3714-3719.

Defect of the Armstrong gun on the score of initial velocity, as compared with the smooth-bore gun, *Scott* 4153-4161——Higher initial velocity obtained with Mr. Bashley Britten's gun in 1859 than with the Armstrong gun, notwithstanding which the former gun was not properly tried, *ib.* 4217-4249. 4311——Opinion that at close quarters it is important to obtain the greatest possible velocity; views of Sir Howard Douglas adverted to hereon, *ib.* 4527-4531.

The slowness of the projectile in leaving the Armstrong gun is not an objection of any moment, *Ewart* 4550, 4551.

Insufficient experience in 1861 on the subject of initial and terminal velocities; uncertainty on this question even at the present time, *Duke of Somerset* 5108. 5134. 5216, 5217——Statement showing that, in addition to the power and accuracy of the 110-pounder Armstrong gun at long range, it has recently been proved that by firing a shot of about 69lbs. with a certain charge of powder, the initial velocity and the effect at short range are equal to that of the old 68-pounder; great importance thereof, *ib.* 5132-5138. 5141——There has in fact been a recent correction of the error that smooth-bore guns preserved a greater velocity than rifled guns, *ib.* 5138. 5216, 5217.

Reports from the Ordnance Select Committee in 1862 on Mr. Whitworth's 12-pounder and 70-pounder guns, with reference more especially to the initial velocities of the projectiles, *App.* 371-375——Results of a comparison between the service shot or shell for the 12-pounder Whitworth gun and the 12-pounder Armstrong gun; also between the Whitworth experimental shot and the Armstrong experimental shot, *ib.* 372-374.

Inner Tubes of Guns. Distinction between witness's gun and the Armstrong gun in regard to the material used for the inner tube; objectionable use of welded coiled iron in the latter gun, *Whitworth* 1311-1319——Taper character of the inner tube of witness's guns, as in the case of the 5½-inch gun, *ib.* 3007.

See also *Steel or Homogeneous Metal.* *Welded Metal* (*Wrought Iron*).

Inspection and Proof of Guns, &c.:

1. *As to the Practice and the Responsibility hitherto in regard to the Inspection of Armstrong Guns at Woolwich.*
2. *Practice in the Case of Contract Supplies, and of Guns from Elswick.*
3. *As to the Final Proof of Guns, and the Powder Charges used in proving.*
4. *Royal Laboratory.*
5. *Question of an Independent Inspection at Woolwich, by an Artillery Officer at the Head of all the Manufacturing Departments.*

1. *As to the Practice and the Responsibility hitherto in regard to the Inspection of Armstrong Guns at Woolwich:*

Statement as to the Inspector of Artillery having been responsible for the proof of the first 169 guns issued, *Anderson* 576-594 —— Defective character of some guns that had passed through the hands of the Inspector of Artillery, *ib.* 599-610——Further evidence as to the inspection of the guns by an artillery officer, before their issue for service; limited means of the Inspector for the discovery of any serious defects, *ib.* 794-835.

Since November 1862 the guns made in the Royal Factory have been issued upon the responsibility of the assistant superintendent, *Gordon* 923, 924——Responsibility of the Inspector of Artillery for the proving and passing of the Armstrong guns first introduced, *ib.* 932-936——The final proof of guns ceased in April 1861, but the Inspector of Artillery still continued to select the guns up to November 1862; examination hereon, *ib.* 936-952. 1018-1025. 1068-1081. 1085, 1086. 2100-2105. 2120-2126.

Witness ceased to be Inspector of Artillery on the 8th July 1861; whilst holding that office he examined 169 12-pounder Armstrong guns, *Tulloh* 2618, 2619——Since the final proof was discontinued, that is subsequently to Lord Herbert's order, the Inspector of Artillery has selected the guns and made records of those received into the service, but has no responsibility whatever in regard to the construction of the guns made in the Royal Factory, *ib.* 2620 *et seq.*——Appointment in the first instance of an officer to inspect the manufacture at Elswick, in addition to the inspection at Woolwich by the Inspector of Artillery, *ib.* 2657-2659——Of nineteen guns rejected by witness when Inspector of Artillery, none were subsequently passed by him, but they have since been dealt with and passed by the superintendent of the Gun Factory, *ib.* 2661, 2662. 2668-2671.

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Inspection and Proof of Guns, &c.—continued.

1. *As to the Practice and Responsibility, &c.*—continued.

Further statement as to witness not having proved the Armstrong guns, nor having been responsible for them, *Tulloh* 2662–2674——Erroneous character of a certain form, stating that the guns were tested by the Inspector of Artillery, *ib.* 2710–2704.

Return of the number of 12-pounder Armstrong guns made at the Royal Gun Factories, proved and passed; and of the number rejected by Major General Tulloh, when Inspector of Artillery (between 8 December 1859 and 7 July 1861); total of 150 guns proved and passed, and of nineteen guns rejected, *App.* 336.

Return showing the number of Armstrong guns manufactured in the Royal Gun Factories which were passed by Colonel Tulloh while he was Inspector of Artillery, showing the number and marks of identity of each gun passed, of those rejected, and of those rejected which were afterwards passed for service, with the date of their issue, *App.* 377–379.

Report of the inspection and final proof of Armstrong guns manufactured at the Royal Gun Factories, and tested by the Inspector of Artillery during the month of June 1860, *App.* 394.

Memorandum of examination of certain 40-pounder and 12-pounder guns; several flaws in the guns recorded, in order to be examined after the guns have been on service, and are returned into store, *App.* 395.

Forms in the office of the Inspector of Artillery in the case of ordnance selected for different stations and services, *App.* 396.

Papers showing that since February 1860 the superintendent of the Gun Factory has been responsible for the final inspection of the guns made in the Gun Factory, and that the Inspector of Artillery has been in no way responsible since that date, *App.* 397–399——Decision by the Secretary of State for War, communicated to the heads of the manufacturing department in February 1860, that as a general principle all stores manufactured in a Government establishment shall be subject only to the inspection of the particular department in which they are made, and that the head of the department shall be held solely responsible for their being of proper quality and durability, and their exact conformity to pattern, *ib.* 397.

2. *Practice in the Case of Contract Supplies, and of Guns from Elswick:*

Independent inspection of the guns made at Elswick, *Tulloh* 2951–2954——More numerous objections in the case of guns made at Woolwich than at Elswick, the number of guns made being much greater at Woolwich; system of inspection at each place adverted to hereon, *ib.* 2958–2965——Probability of an equally rigid inspection of contract articles by the heads of departments at Woolwich as of articles made by themselves, *ib* 2967–2972.

Circumstance of the cast-iron guns having been made for Government by the trade, under the superintendence of a military officer, *Sir W. G. Armstrong* 3518-3524.

Decision by the Secretary of State in February 1860, that all stores supplied by the trade of the country shall be inspected by officers specially appointed for that duty by the War Department, the contractor being under no responsibility to the Government for articles once accepted, *App.* 397.

3. *As to the Final Proof of Guns, and the Powder Charges used in proving:*

Information relative to the charge of powder used in the proof of the Armstrong gun, *Sir W. Wiseman* 298–300. 305–308——Proof of about 300 of the guns first issued, by firing ten rounds with each gun, with a charge of 1¾ lbs.; question considered as to the sufficiency of this test, *Anderson* 820. 837–853——Reference to the proof charge in the case of the Armstrong gun; a special proof is also laid down for the Whitworth and other rifled guns, *Gordon* 940, 941. 1087–1098——Charge of 1¾ lbs. used for the ten final proof rounds with the Armstrong 12-pounder, the service charge being 1¼ lbs., *ib.* 940, 941.

Expediency of testing the Armstrong heavy guns by firing quickly twenty or twenty-five rounds with the service charge, and six or eight degrees of elevation, *Seymour* 2305.

Unduly severe test to which the Armstrong guns were at first subjected; the proof is now reduced, *Tulloh* 2674–2677——Further statement opposed to the use of very heavy charges in proving guns; severe proof in the case of a Whitworth gun tried at Shorncliffe, adverted to hereon, *ib.* 2779–2797——Return of wrought-iron guns burst at proof, *ib.* 2797——Duty of Mr. M'Kinlay, the proof master at the Gun Factory, merely to see that the proof was carried on safely, *ib.* 2856, 2857.

Excessive proof to which the 70-pounder 5½ gun, and other guns of witness, are about to be submitted under the eye of the Committee appointed for the purpose, *Whitworth* 2988–2993.

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Report, 1863—*continued.*

Inspection and Proof of Guns, &c.—continued.

3. *As to the final Proof of Guns, &c.*—continued.

Tendency to injure the gun by putting in double charges of powder in testing, *Duke of Somerset*, 5130.

Copy of correspondence in 1860 with reference to the firing of ten rounds from Armstrong guns, in addition to the ordinary proof before leaving the Arsenal; question also considered as to the mode of superintendence of the final proof, *App.* 333–336.

Statement by Ordnance Select Committee in April 1862, that the proof-charge of 27½ lbs. of powder for the 110-pounder is not too great, *App.* 339.

4. *Royal Laboratory.*

Different instances of complaints as to the quality or pattern of articles issued from the Royal Laboratory, where an Artillery officer is in charge, *Bingham* 348–365. 431.

Explanatory statement relative to shells and rockets issued from the Laboratory, and said to be complained of; witness being responsible for the manufacture and inspection, *Boxer* 866–892.

5. *Question of an independent Inspection at Woolwich by an Artillery Officer at the Head of all the Manufacturing Departments:*

Impossibility of bad manufacture if the inspection had been efficient; consideration hereon of the circumstance of the inspector at Woolwich not being an Artillery officer, *Sir W. Wiseman* 231–264.

Improbability of the accident to the vent-piece of an Armstrong gun, in certain trials at Portsmouth, having happened, if the guns during manufacture at Woolwich, and as issued to the service, had been under the charge of an Artillery officer, *Bingham* 345. 519–523——Several instances of failure at proof of cast-iron guns issued from the Gun Factory when under an Artillery officer, *ib.* 346, 347. 424, 425——Issue of certain defective guns attributed to insufficiency in the inspection, and to the circumstance of the head of the Gun Factory not being an Artillery officer, *ib.* 370, 371. 403–420. 468. 508, 509.

Evidence in favour of each of the manufacturing departments at Woolwich being under an Artillery officer, with another Artillery officer at the head of the whole, who should be responsible for all articles issued, *Bingham* 371. 410, 411. 426 *et seq.*——Further statement as to the advantage of a general inspection at Woolwich, independent of the manufacture, *ib.* 427 *et seq.*——Importance of a general inspection as a check upon deviation by any department from the proper pattern, and as a means of ensuring that the different manufactures duly coincide; illustration hereon of the defect of the present system, *ib.* 462–483. 525–528.

Expediency of a military man rather than of a civilian, as the general head of the manufacturing departments, *Bingham* 484–486——Advantage also of a military man in separate charge of each department, *ib.* 877–896.

Importance of the heads of the several departments at Woolwich being responsible for the inspection, rather than of having an independent inspection over all, *Clerk* 912–926——Advantage of the manufacture of guns being inspected by an Artillery officer, *ib.* 918–925.

Advantage if there were an independent inspection of all guns after manufacture at Woolwich, *H.R.H. the Duke of Cambridge* 1223–1228. 1253–1256. 1259——Expediency of an independent inspection of all Government manufactures, *ib.* 1237, 1238——Decided improvement if there were an officer at the head of all the Arsenal, *ib.* 1255, 1256.

Respects in which advantage would result from an independent check upon the manufacture, although during the Russian war no evil was attributable to the present system of heads of departments without a superintending chief, *Tulloh* 2861 *et seq.*——Advantage in the independent inspection being continuous during manufacture, *ib.* 2902–2927.

Recommendation by a Committee of Artillery Officers, comprising General St. George, and Colonels Taylor and Bingham, that all "matériel" should be submitted to a careful inspection, other than that of the manufacturer, before being admitted into the service, *App.* 331——Full concurrence of the Commander-in-Chief with the foregoing recommendation, *ib.* 332.

See also *Lined Guns* (12-*pounders*) 3.

Inventors. Desire expressed by witness, in his letter to the "Times" in November last, to aid the public service in every way in his power, *Whitworth* 1130——Explanations as to the date at which witness first turned his attention to, or undertook the construction or rifling of ordnance on an improved principle, *ib.* 1329–1353.

Necessity of using the merits of more than one system in order to obtain a perfect gun; every facility in given is this respect by the Royal Gun Factory, *Anderson* 1984–1991.

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Inventors—continued.

Witness as an inventor has not hitherto encountered difficulties from the Ordnance Select Committee, but has heard other inventors complain, *Richards* 4027-4029—— Advantage to Sir William Armstrong, as an inventor, in his being present at trials with guns of other inventors in his capacity as Engineer of Rifled Ordnance, *ib.* 4053-4062.

Grounds for the conclusions that other inventors were not properly brought into competition with Sir W. Armstrong, *Scott* 4168-4172. 4217-4219; *Blakely* 4621. 4746-4748. 4894. 4904. 4913-4922——Probability of the inventions of Mr. Britten and others not having been properly tested, because of a pre-determination in the authorities to make some plan of Sir W. Armstrong's successful; official position of Sir W. Armstrong and functions of the Ordnance Select Committee adverted to hereon, *Scott* 4252-4275——Difficulty, but for the Admiralty, in witness obtaining from the Ordnance Select Committee a trial of his gun, *ib.* 4311——Further statement as to the undue facilities given to experiments with the guns of Sir William Armstrong, as compared with the guns of other inventors, *ib.*

Particulars connected with offers by witness in 1860 and 1861 to provide a 9-inch and a 12-inch gun at his own expense, and to guarantee them, and lend them to Government free of charge; complaint as to these offers not having been accepted, without the condition that the drawings should first be submitted to and approved by the Ordnance Select Committee, *Blakely* 4756-4764. 4770-4799——Explanation as to the unwillingness of witness, as an inventor, to accede to the condition that the Ordnance Select Committee should examine and approve the drawings for the gun offered by him; position and influence of Sir W. Armstrong adverted to hereon, *ib.* 4773-4795——Opinion that any inventor offering to supply a gun at his own cost should be allowed to do so without being required to submit beforehand an outline or drawing of his invention, *ib.* 4796-4799.

Further explanation on the subject of witness's disinclination to submit drawings of his gun to the Ordnance Select Committee, *Blakely* 4867-4880. 4892-4894——Disapproval generally of inventors having to submit their plans so that they shall come under an official who is himself an inventor, *ib.* 4874-4880. 4892-4894——Several instances in which witness has not been treated quite fairly by the War Office; he does not however volunteer any complaint, *ib.* 4881-4891——Complaint as to the inadequate opportunities given to inventors generally to come forward; before the final adoption of the Armstrong system, *ib.* 4916-4922.

Opinion as to inventors not being very fond of the Ordnance Select Committee, *Duke of Somerset* 5145——Further expression of the opinion that the most perfect gun can best be arrived at by the united action on the part of inventors, *Anderson* 5560.

See also *Armstrong Guns*, 1. 2. *Blakely Guns.* *Britten, Bashley.* *Brunel, the late Mr.* *Coil System.* *Experiments.* *Lancaster Guns.* *Ordnance Select Committee.* *Projectiles or Shells.* *Whitworth Guns and Projectiles.*

IRON-PLATED SHIPS:

Result of the experiments with the Armstrong and Whitworth guns against the iron target; greater effect of the latter as regards the "Warrior" target, *Gardner* 57-62. 99——More damaging effect at short range of the 68-pounder than of the Armstrong 110-pounder against iron-plated ships, *Coles* 1576. 1583-1585. 1611-1613. 1633-1640; *Cochrane* 2237.

Reference to the fact of witness's four-ton gun having penetrated plates, when the service four-ton gun failed to do so; this was due to the temper of the shot, *Whitworth* 2006. 2021-2030. 2046-2050——Explanation as to the mode of construction and the performances respectively of two guns made for witness at Woolwich, and of two guns made at Manchester; it was one of the former guns that was found so successful against iron plates, *ib.* 2053-2071——Reference to a statement by the Ordnance Select Committee that spherical shot would be most effective against iron-plated ships at very short distances, *ib.* 2350-2353——Different guns of witness which have been used against plated targets at Shoeburyness, and important results obtained, *ib.* 2489.

With regard to the power of witness's guns to pierce armour plates, it is not even yet decided what thickness or strength of plates artillerists may be called on to penetrate, nor is it at all determined what the capability of ships for carrying heavy guns shall be, *Sir W. G. Armstrong* 3225——Everything was uncertain as to the plating of ships when witness designed his gun, *ib.* 3225, 3226——There are experimental guns that could pierce the "Warrior" target at 1,000 yards, but no such guns are in the service, nor is it reasonable to expect that there should be, *ib.* 3226——Several experimental or pattern guns, which witness has now completed, for the purpose of dealing with armour-plated ships, forts, or casemated defences, *ib.* 3226, 3227.

Favourable opinion of the Iron-plate Committee in regard to witness's 300-pounder muzzle-loading gun of 12 tons, *Sir W. G. Armstrong* 3227——Grounds for concluding that it will be necessary to use guns of a very large calibre in order to destroy armour-plated ships, *ib.*——Opinion that nothing less than a bore of nine inches will be adequate for this purpose, *ib.*

Inferiority

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IRON-PLATED SHIPS—continued.

Inferiority of the rifled breech-loader, as compared with the smooth-bore, for the penetration of iron plates, on account of the less initial velocity of the rifled gun, *Jerningham* 3646, 3647. 3694–3700——It would, however, be useless to employ the 68-pounder against iron plates at a greater distance than 200 yards, *ib.* 3695.

Circumstance of an experiment in the autumn of 1860 having shown that the Armstrong 80-pounder was inferior to the 68-pounder smooth gun against iron plates, *Scott* 4116. 4122–4125——Inferiority at the present time of the Armstrong naval gun as compared with the smooth-bore against plated ships, *ib.* 4124–4128——Circumstance of the Horsfall smooth-bore gun having pierced iron plates at a distance of 800 yards; great weight of this gun, *ib.* 4163–4167.

Risk incurred respectively by iron and wooden ships in passing by a battery of Armstrong guns at 1,000 yards, *Ewart* 4594–4598——Great danger to an iron-plated vessel if penetrated by a shell, *ib.* 4599–4603.

Enormous expenditure incurred without the production of any guns, in general use in the Navy, sufficiently powerful to operate against iron-clad ships, *Blakely* 4607–4609——Immense expenditure in the construction of an iron-clad fleet, which after all is incapable of resisting the powerful ordnance of France, *ib.* 4609–4611——Letter from witness to the Duke of Somerset, in October 1860, offering to supply at his own cost a gun capable of penetrating iron-plated ships, *ib.* 4760——Every gun not capable of penetrating iron-plated ships should be rejected, *ib.* 4814. 4821——Witness considers the 68-pounder smooth-bore quite ineffective against iron-plated ships, *ib.* 4821, 4822.

Now that iron ships are being so extensively introduced, the Armstrong gun is not sufficiently powerful at short ranges, *Duke of Somerset* 5102. 5108. 5121–5123——Reference to the success of a Whitworth gun in piercing a 4½-inch plate of the "Trusty," *ib.* 5154. 5183. 5193.

Return from Her Majesty's ship "Excellent," in October 1858, containing details of trials with the Whitworth 68-pounder, in order to ascertain its effects against iron plates, *App.* 416, 417.

Particulars of trials, in August and September 1861, with the 100-pounder Armstrong gun against an angular target composed of four plates of rolled iron, &c., of different thicknesses, &c., *App.* 440–443.

Record of all trials at Shoeburyness with Armstrong rifled 300-pounder guns against iron plates, with full particulars as to the results obtained, *App.* 521–523.

Conclusion of the Committee, that the old 68-pounder is the most effective gun in the service against iron plates, *Rep.* vii.

See also *France.* "*La Gloire.*" "*Warrior,*" *H. M. S.*

Issue of Stores. With regard to the practice as to the issue of stores at Woolwich, it is the duty of witness to see that all stores issued have been duly proved and passed previously, *Gordon* 927–931.

J.

Jeffrey, Mr. Advantages possessed by the guns of Mr. Jeffrey and Mr. Britten, whereas they were never tried under the same conditions as the Armstrong gun, *Scott* 4168–4172. 4217–4249.

Jerningham, Captain Arthur William, R.N. (Analysis of his Evidence.)—Has had an experience of nearly thirty years in naval gunnery; was for five and a half years in command of the "Cambridge" gunnery ship, 3616–3622——Great accuracy of the Armstrong 12-pounder and 40-pounder, when the range is properly known, 3622–3626. 3632, 3633——Instance of witness having fired 192 rounds with a 40-pounder without any material check, 3626. 3723, 3724——Checks however have been constantly experienced by witness in his practice with the Armstrong guns on account of some fittings being deficient, 3626. 3723–3732——With proper care these defects are for the most part capable of an early remedy, 3626.

Unsatisfactory character of the fuzes hitherto used with the Armstrong naval guns, 3626–3630——Impression as to the unreliable character of the 110-pounder on account of the liability of the vent-pieces to give way, 3631, 3632. 3686–3688. 3701–3703. 3754–3760——Opinion that too much has been yielded to the fancy of the mechanic in finishing up the guns, 3633——Good character of the Armstrong recoil carriage, *ib.*——Room for improvement in the elevating gear and other appliances, *ib.*——The nicety sought for in the sights is altogether too fine, 3633. 3637.

Great value of the 110-pounder if the defect in regard to the vent-pieces can be obviated, 3633–3637. 3662. 3703. 3754–3757——Exceedingly destructive character of the 110-pounder shell, 3633——Great defect of rifled guns in regard to ricochet firing,

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Jerningham, Captain Arthur William, R.N. (Analysis of his Evidence)—*continued.*

on account of their tendency after striking to deflect to the right, 3638, 3639. 3714—— Opinion as to the great endurance of the Armstrong guns, 3639-3641. 3745-3747—— Difficulty in regard to drawing the charge of rifled guns, when going into harbour; suggestion hereon, 3641. 3748.

Instances of vent-pieces having given way in the case of the 40-pounder and 12-pounder guns; on the whole, however, the vent-piece is quite satisfactory up to the 40-pounder, 3641–3645. 3734——Important advantages of breech-loaders over muzzle-loaders if the vent-pieces can be perfected, 3646. 3709–3711. 3752–3754——Inferiority of the rifled breech-loader, as compared with the smooth-bore, for the penetration of iron plates, on account of the less initial velocity of the rifled gun, 3646, 3647. 3694–3700.

Great care necessary in the use of the Armstrong gun; doubt as to the gun being particularly objectionable on this score during the heat of action, 3648–3650. 3754–3766 ——Further reference to the fuzes used with the Armstrong guns; defects of the pillar fuze, the time fuze, and the percussion fuze, 3651–3653. 3680–3685. 3720, 3721—— Various kinds of powder used with the Armstrong guns; doubt as to the thick smoke being caused by any peculiarity in the powder, 3654. 3690–3693.

With regard to the question as to the propriety of so large an expenditure on Armstrong guns, witness considers that too large a number of 110-pounders were made whilst the vent-pieces were yet unsatisfactory, 3656–3679. 3686–3689. 3749——Doubt as to the efficiency of the French cast-iron rifled guns; disapproval of the adoption in this country of similar guns in lieu of wrought-iron guns, 3660–3674. 3750, 3751——Dissatisfaction and prejudice in the navy in regard to the larger Armstrong guns, on account of the defects in regard to vent-pieces, &c., 3688——Favourable opinion entertained of the new weapon by those instructed in gunnery ships, 3688. 3704——Anticipation that in course of time the prejudice against rifled guns will disappear, and that they must eventually be adopted, 3705–3708.

Great advantage of the Armstrong projectile, as compared with the Whitworth projectile, on account of the lead coating, 3712, 3713——Superior advantages of the rifled gun over the smooth-bore, if it could fire with accuracy and range, not only elongated, but spherical projectiles, and if a great initial velocity could be secured, 3714-3719—— Objection to coating spherical shot with lead, 3719——The use of slow-burning powder with the Armstrong gun does not interfere with accuracy of aim, 3733——Further statement as to the accuracy of the gun at sea; even in rough weather witness has found it more accurate than the common service gun, 3735–3743——In general action, in rough weather, witness would, however, prefer on the whole the smooth-bore gun, unless for some especial purpose; explanation hereon, 3744.

Jerningham, Captain. Sundry reports by Captain Jerningham, explanatory of the practice with Armstrong guns on board the "Cambridge," and of the several defects experienced in the guns, *App.* 320–327.

Jervis, Captain (Member of the Committee). Draft Report proposed by Captain Jervis; adoption, instead, of the Report of the Chairman, with sundry amendments, *Rep.* xxi. xxiii.

K.

Krupp's Guns. Severe test to which the Krupp gun has been subjected without injury, *Gardner* 71——Disapproval of the use of the same amount of steel as in Krupp's guns, *Anderson* 668–671——Great value attached to the system of manufacture of Krupp, of Essen, *Whitworth* 1454——Excellent character of the 100-pounder, at Woolwich, made by Krupp, *Anderson* 1938-1942.

Reference to the recent bursting of one of Krupp's steel guns at Woolwich, *Tulloh* 2728, 2729. 2734-2746——The trials made with Krupp's guns, as well as the difficulty of securing steel uniformly good, did not justify the manufacture of guns upon Krupp's principle, *Sir W. G. Armstrong* 3944–3948.

Very severe test stood by the Krupp 100-pounder steel gun, *Scott* 4439. 4447—— Statement as to Krupp's guns being made from steel, cast and hammered, *ib.* 4450–4458–4460——Failure of some small steel guns of Krupp, tried in 1851, *ib.* 4461, 4463.

L.

"La Gloire," The. The 68-pounders or the 100-pounders in the "Warrior" would not be effective against the "La Gloire," *Blakely* 4821, 4822. 4829. 4832——Much more effective character of the armament of "La Gloire," than of the "Warrior," *ib.* 4823–4828. 4833.

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LABORATORY:

1. *As to the Issue of Defective Shot and Shell from the Laboratory.*
2. *Efficiency of the Management generally.*
3. *As to the Non-Manufacture, from the first, of Armstrong Projectiles, &c., at the Laboratory.*
4. *Cost respectively at the Laboratory and at Elswick.*
5. *System of Accounts.*

1. *As to the Issue of Defective Shot and Shell from the Laboratory:*

Evidence as to the complaints made against shells and rockets issued from the Royal Laboratory, an artillery officer being in charge, *Bingham* 348-365. 431-436——Statement as to a great number of 10-inch shells having been issued to the service, which were over the proper weight; improbability of this having occurred if there had been an independent inspection, *ib.* 354-365. 480-483——Great complaints made about these shells, on account of their being over their proper weight, *ib.* 354-357——The shrapnell shells complained of were made in 1854 and 1855, *ib.* 362——The shells substituted for the shrapnell shells were also largely complained of, chiefly as regards the pattern, *ib.* 363-365.

Explanatory statement relative to the evidence of Colonel Bingham as to the 10-inch shells made in the Royal Laboratory having been too heavy, *Boxer* 866-885——Non-objection to a margin of 5 lbs. or 6 lbs. being allowed with reference to the contract weight of the 10-inch shells, *ib.* 870-876——Explanation also on the subject of rockets, *ib.* 886-892——Explanation of a statement as to some shells having been made in the Royal Laboratory of a diameter beyond that authorized, *ib.* 893-895.

Report made by witness in 1860 as to the excessive weight of some 10-inch shells issued for land service, *Clerk* 909——Question as to the extent to which the shells may be considered obsolete or unserviceable, *Gordon* 997, 998. 1037-1048. 1082-1084——Expense of 50,000 *l.* or 60,000 *l.* on account of shells now decided to be obsolete, *ib.* 2094——Issue of 175,532 shells of the pattern now obsolete, *ib.* 2099.

Communication from Lieutenant Colonel Clerk to the superintendent of the Royal Carriage Department, dated 15 August 1860, relative to the overweight of the 10-inch shells used for the land service, *App.* 300, 301.

Report of the Select Committee on Ordnance relative to the 10-inch shells, and the weight of such shells as made in the Royal Laboratory; recommended uniformity between the shells for land service and sea service, *App.* 301, 302.

Statement by Colonel Bingham of the views of the Commander in Chief upon this subject, showing his disapproval of the issue of shells of a different weight and pattern from that authorized, and intimating that such shells must be put aside as unfit for use, *App.* 302.

Papers relative to the question of converting those shells which are above the authorised weight, to be used with mortars, *App.* 302-304.

Total of 6,609 10-inch shells, reported from Gibraltar and Corfu as exceeding 85 lbs. in weight, whilst 4,688 shells have been received at Woolwich from home stations as exceeding that weight, *App.* 304.

2. *Efficiency of the Management generally:*

Enormous extent of the manufacture in witness's department, whilst he has always been led to believe that his conduct of the department has given the greatest satisfaction, *Boxer* 899, 900.

Excellent and economical management of the Royal Laboratory, so that a competing establishment would probably not be beneficial, *Baring* 5272.

3. *As to the Non-manufacture, from the first, of Armstrong Projectiles, &c. at the Laboratory:*

Explanation as to the Armstrong projectiles not having been made, in the first instance, at the Laboratory, *Baring* 5273. 5276-5282——Circumstances under which the larger portion of the supply of projectiles for 1861-62 was given to the Laboratory, *ib.* 5273——Whilst the Estimates for 1861 were under consideration, it was stated by Colonel Boxer that he could make the projectiles much cheaper than they were made for at Elswick, *ib.*

Statement showing the entire willingness of witness to have carried out any instructions for manufacturing ammunition and projectiles for the Armstrong gun, *Boxer* 5708. 5710. 5740-5748——Circumstances under which it was decided that the shells and fuzes should, in the first instance, be made under the superintendence of Sir W. Armstrong instead of in the Royal Laboratory, *ib.* 5709. 5737-5739——Opinion that if Sir W. Armstrong had taken for his guide the experience of the Laboratory in regard to fuzes, he would have arrived at a better result, *ib.* 5711-5713——Statement that there would have been no difficulty, in the first instance, in carrying out the manufacture in the Laboratory, under the superintendence of Sir W. Armstrong; reference hereon to an

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3. *As to the Non-Manufacture, from the first, &c.*—continued.

exception taken by Sir W. Armstrong in 1861, to the mode in which witness was making some projectiles, *Boxer* 5739–5748.

4. *Cost respectively at the Laboratory and at Elswick:*

With an additional outlay of about 1,000 *l.* on machinery, witness could have made in the Royal Laboratory all the fuses and shells supplied from Elswick and Woolwich, *Boxer* 5714. 5719, 5720——Facilities for cheaper manufacture, from the first, at the Laboratory than at Elswick, *ib.* 5715. 5723——There had been more experience at the Laboratory than at Elswick in manufacturing projectiles, so that they could have been made cheaper from the first, *ib.* 5715.

Correction as to the accuracy of the calculations and accounts of the cost of production at the Laboratory; large public saving if all the projectiles had been made there, *Boxer* 5716-5719——Effect of the competition of the two establishments to reduce the cost at Elswick, but not at the Laboratory, *ib.* 5721–5723.

Total of 342,100 *l.* 1 *s.* 7 *d.* expended in the Royal Laboratory up to 31 March 1863, upon projectiles, &c. for the Armstrong guns, *App.* 480——Statement showing the cost of projectiles and of fuzes obtained from the Elswick Ordnance Company, compared with the rates of those produced at the Royal Arsenal, Woolwich, *ib.* 481, 482.

Statement of the cost of ammunition, &c. for Armstrong guns made in the Royal Laboratory, and at Elswick, to 31 March 1863; total of 297,169 *l.* 8 *s.* 10½ *d.* at the Laboratory, and of 396,000 *l.* 5 *s.* 11 *d.* at Elswick, *App.* 585.

5. *System of Accounts:*

Reference to the circumstance of the general charges of the Laboratory, not including any item for rent, no rent being paid, *Boxer* 5724. 5727—— Charges incurred in experiments and alterations are included in the calculations of cost, *ib.* 5731——Repairs and trifling alterations of machinery are also charged in the yearly cost, *ib.* 5732, 5733——Any very large alterations of machinery, increasing the value very much, would be charged to plant, *ib.* 5733——Expediency of the Laboratory balance sheet giving the items more in detail; the accounts themselves are always kept in great detail, *ib.* 5734–5736.

See also *Fuzes.*

Labour and Material (*Armstrong Guns*). Cheapness of the metal for the Armstrong gun, whilst the labour is very expensive, *Whitworth* 2614, 2615——There is no difficulty of any moment in the construction or working of the materials if the proper metal can be had, *Sir W. G. Armstrong* 3512–3517——Opinion that too much has been yielded to the fancy of the mechanic in finishing up the guns, *Jerningham* 3633.

See also *Accounts* (*Woolwich Departments*). *Welded Metal* (*Wrought Iron*).

Lancaster Gun. Superiority of the Armstrong gun over the Lancaster gun, the latter, however, not being a wrought-iron gun, *Coles* 1593–1596. 1614–1618——Reference to the circumstance of both the Lancaster guns used at Kinburn having burst, *Seymour* 2321——Objection to the Lancaster system, as involving the principle of mechanical fit, *Sir W. G. Armstrong* 3915. 3922. 3924.

Letter from Mr. Lancaster to the Special Committee on Rifled Cannon, dated 15 October 1858, with reference to his views on the subject of rifled ordnance, *App.* 400.

Large Guns. Improvement required in all large rifled guns that witness has seen before their general adoption in the service, *Sir W. Wiseman* 293, 294——The manufacture of large guns by witness was only commenced about a year ago; he has now a 150-pounder in course of manufacture, *Richards* 4028——For very large guns, cast-iron or brass is more applicable than coiled iron for the tube, *Blakely* 4640–4642.

See also *Navy, The. One hundred-Pounders or* 110-*Pounders. Six hundred-Pounders. Three hundred-Pounders. Vent-pieces,* 3.

Lauderdale, Right Hon. the Earl of, K.C.B. (Analysis of his Evidence.)—When in command of the Pacific Station had a limited opportunity of observing the practice with some 110-pounder Armstrong guns, and considers that at sea they are hardly so accurate as the old 68-pounders, 2136–2142. 2156–2158——For a naval action would prefer a large proportion of 68-pounders as compared with the heavy Armstrong guns, 2143–2146. 2166–2168——The Armstrong gun is more complicated and more easily disabled than the old gun, 2144, 2145. 2159, 2160——For bombarding towns at a distance from ships, or for land service, the Armstrong gun is most valuable, 2147, 2148. 2155. 2162–2164.

If the Armstrong guns are frequently fired with very heavy charges, they will probably soon show symptoms of giving way; number and character of flaws in the welding of the guns adverted to hereon, 2150–2155. 2161——Expediency of guns of a special kind being used in arming ships for special work, such as an attack on forts, 2163–2167——Efficient character of the old 30-pounder rifled gun in use in the French navy, 2169, 2170.

Lead

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Lead Coating of Projectiles. See *Coating of Armstrong Projectiles.*

Lined Guns (12-*Pounders*):

1. *As to the Pattern of the* 12-*pounder Lined Gun.*
2. *Defective Character of the Lined Guns; Inquiry instituted into the matter.*
3. *Authorities responsible for the Inspection and Proof of these Guns.*
4. *Explanatory Statements by Sir W. Armstrong and Mr. Anderson.*
5. *Discontinued Issue of Lined Guns, those in the Service being withdrawn.*

1. *As to the Pattern of the* 12-*pounder Lined Gun:*

The sealed pattern 12-pounder is a lined gun; manufacture of the greater number of these guns before the pattern was received at the Gun Factory, *Anderson* 546–549——Authorities by whom the pattern 12-pounder was recommended and was sealed, *ib.* 551–559——Explanation on the question of deviation from the pattern, in regard to the bouching or lining, &c., *ib.* 595–598. 616–619, 697–720. 766–793.

Authorities responsible for the pattern of the lined gun now condemned as unserviceable, *Gordon* 1015–1017——Responsibility primarily of the Ordnance Select Committee for the sealing of the pattern of the lined gun, *His Royal Highness the Duke of Cambridge* 1230, 1231.

2. *Defective Character of the Lined Guns; Inquiry instituted into the matter:*

With regard to many Armstrong guns having of late proved very unsatisfactory, witness attributes this to bad manufacture, *Sir W. Wiseman* 226–230——Perfect confidence of witness in the Armstrong gun up to last autumn, when, at the ordinary practice at Shorncliffe, six of the guns became unserviceable, *Bingham* 366——Inquiry instituted, through a committee of artillery officers, into the foregoing matter, when it was found that the guns in question (as well as many others in the service) had been found faulty at the first proof, and, in order to save expense, had been patched up and issued, *ib.* 366–369. 372, 373. 377–387. 391–403.

The committee of artillery officers referred to by Colonel Bingham were appointed by witness in order to inquire into certain alleged defects in the Armstrong field guns, *His Royal Highness the Duke of Cambridge* 1218, 1219——About half the Armstrong field guns are lined, and it is a question whether they are not on that account defective, *ib.* 1220. 1236——Belief as to certain guns which recently proved defective at Shorncliffe having been lined guns, *ib.* 1257–1262.

Cost of about 45,000 *l.* involved in the guns declared by the artillery committee to be unserviceable, *Gordon* 2094——Total of 362 guns made at Woolwich and of 76 at Elswick, which were said by the committee to be defective, *ib.* 2097, 2098. 2127, 2128.

Approval of the experiment made with the lined guns; these guns are not a fair test of Sir W. Armstrong's principle, *Noble* 3141–3148——The experiment, though it failed, was justifiable, *ib.* 3145, 3146——The use of these guns in the service should not be continued, *ib.* 3147.

Very serious character of the inquiry in the case of three of the guns which failed at Shorncliffe, *Scott* 4418–4421.

Conclusions and recommendations arrived at by the committee of artillery officers, with reference to the several defects in the guns tried at Shorncliffe, *App.* 328–332.

Reference to the defective character of the guns which were lined after the sealed pattern; denial by Mr. Anderson that the lining was the cause of failure of some of these guns, *Rep.* vi, vii.

3. *Authorities responsible for the Inspection and Proof of these Guns:*

Evidence on the question of the Inspector of Artillery having been responsible, up to November last, for the inspection and proving of the guns made at the Gun Factory, with reference more especially to the issue of lined guns, *Gordon* 932–952. 1018–1025. 1068–1081. 1085, 1086——Means of the Inspector of Artillery for knowing that certain guns selected by him were lined guns, *ib.* 994, 995——Further statement as to the Inspector of Artillery having, up to November last, examined and selected the guns issued to the service, and since complained of, *ib.* 2100–2105. 2120–2126.

None of the guns referred to in the Report of the Committee of 17th November 1862 as having failed were inspected by witness; they underwent the usual proof, *Tulloh* 2620–2622. 2705–2718——Two lined guns were passed by witness, but he had no idea that they had been lined, *ib.* 2622. 2649–2656.

List of nineteen 12-pounder guns rejected by Major General Tulloh, when Inspector of Artillery, showing the dates when they were subsequently passed into the service, all of these guns, except two, having been lined, *App.* 336.

Return showing the number of Armstrong guns manufactured in the Royal Gun Factories, which were passed by Colonel Tulloh, whilst he was Inspector of Artillery;

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LINED GUNS (12-*POUNDERS*)—continued.

3. *Authorities responsible for the Inspection and Proof, &c.*—continued.

showing also the number and marks of identity of each gun passed, of those rejected, and of those rejected which were afterwards passed for service, with the date of their issue, *App.* 377-379.

4. *Explanatory Statements by Sir William Armstrong and Mr. Anderson.*

Inaccuracy of the evidence of Colonel Bingham as to certain 12-pounders made in 1859 having failed on account of the lining or bouching, *Anderson* 547 *et seq.* 672-688 ——Excellent character of the gun condemned by Colonel Bingham, *ib.* 550. 567—— Variation in regard to the practice of putting in the lining of different guns, *ib.* 563-565 ——Unserviceable character of three of the guns alluded to by Colonel Bingham, but not in consequence of the linings, *ib.* 568, 569. 620 *et seq.*——Due consideration by Sir W. Armstrong and witness before deciding upon lining the guns, *ib.* 610-612. 649-655.

Reference to certain diagrams, and explanations thereupon, showing in detail the character of the defects in three of the guns complained of as having been "patched or lined," *Anderson* 620-642. 647, 648. 675——Witness is not aware of any large number of guns having been complained of as unserviceable on account of the linings, *ib.* 656-660——Only one of the 14 guns condemned as unserviceable really failed in the bouching, *ib.* 677-686——Five different reasons assigned by witness in a report to the War Office, as accounting for the imperfections in the guns of 1859; belief as to the concurrence of Sir W. Armstrong in regard to four of these objections, *ib.* 687-692. 722, 723——Small expense involved in the lining of guns, *ib.* 733-735.

Out of fourteen guns that have come back defective four have had something wrong with the lining, *Anderson* 1971, 1972——Two guns which recently proved defective at Shorncliffe were not lined guns; nature of the defects, *ib.* 1973-1977.

Explanatory statement relative to five defective guns at Shorncliffe, out of two batteries of twelve guns, *Sir W. G. Armstrong* 3230-3237——Statement showing that although several of the lined guns have failed a great number have successfully borne a very large amount of firing, *ib.* 3253——Circumstance of the lined gun having been subjected to the usual proof and having stood it perfectly well, *ib.*——Full approval given by witness to the lining of the guns, which was first suggested by Mr. Anderson, *ib.* ——Witness admits that the lining was a mistake, but it was a justifiable one, *ib.*

Reference to the defects elicited last autumn in some of the guns and vent-pieces first made, when the manufacture was not properly perfected; rapid firing had nothing to do with these defects, *Sir W. G. Armstrong* 3452-3464——Further statement as to some of the lined guns having proved trustworthy, *ib.* 3535. 3537——Satisfactory character of the lined guns if re-barrelled, which would not cost much more than 10 *l.* per gun, *ib.* 3536-3540.

Reference to two failures of a different nature at Shorncliffe owing to the system of lining of field guns, *Sir W. G. Armstrong* 3590-3596——Conclusion as to a gun which failed from a crack in the coil having been one of the earlier guns and made of defective material, *ib.* 3597-3603——With regard to the failures generally during experiments last year at Shorncliffe the guns were defective only by reason of want of experience in their construction; explanation hereon that the guns tried at Portsmouth did not fail, *ib.* 3604-3615.

Further information relative to the extent and nature of the defects in the guns tried at Shorncliffe, that is upon the occasion when twelve guns were tried, five of which proved defective, *Sir W. G. Armstrong* 3813-3839——Six guns were returned from Shorncliffe, but one of them was only defective in the breech-screw, and the remedy might easily have been applied on the spot, *ib.* 3815-3817. 3836-3839——Out of five defective guns (out of twelve tried at Shorncliffe) two were lined guns; character of the injuries to each of these, *ib.* 3815-3827.

Explanatory statement relative to the recent trial of witness's guns at Portsmouth, with reference more especially to the character of the defects in two guns said to be seriously injured, *Sir W. G. Armstrong* 3840-3846.

5. *Discontinued Issue of Lined Guns, those in the Service being withdrawn:*

Steps taken for withdrawing from the service the faulty or lined guns used from Woolwich, *Bingham* 388——The issue of lined guns has been discontinued, *Tulloh* 2671, 2672——Impropriety of the alteration of pattern, which led to the lining of some of the guns; this is now put a stop to, *ib.* 1235, 1236. 1260——Several changes in the sealed pattern, the present pattern being a lined gun, *Gordon* 2129-2134.

Statement as to there not having been any sealed pattern or drawing of the 12-pounder gun, and as to the approved or original drawing not having contemplated a lined gun, *Sir W. G. Armstrong* 3246-3253.

Lubrication. With regard to the careful washing and drying said to be necessary with witness's gun, he was the first to introduce the system of lubrication, which has been found

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found quite successful, *Whitworth* 3031——Effect of the lubrication in preventing cohesion or injury, by the use of mechanically fitting projectiles, *Scott* 4477–4780.

Detail of experiments in order to ascertain whether when using Colonel Boxer's lubricators with the Armstrong guns, the application of the sponge would be necessary during the practice; satisfactory results obtained, *App.* 449, 450.

See also *Wads.*

M.

Martello Towers. Statement as to the much more satisfactory results produced by Armstrong guns than by the old smooth-bores in practice against martello towers in the autumn of 1861, *Baring* 5397, 5398.

"Melpomene," H. M. S. Witness commanded the "Melpomene" for four years, her armament comprising five 110-pounder Armstrongs and eight 40-pounders, out of thirty-five guns in all, and details the result of practice with these guns, *Ewart* 4534 *et seq.*—— Absence of apprehension on board the "Melpomene," through fear of accidents with the Armstrong gun, *ib.* 4589–4592.

Mercer, Captain, R.A. Reports from Captain Mercer, commanding Royal Artillery in New Zealand, in 1862–63, relative to the operation of the Armstrong guns, and the defects experienced; very favourable conclusion on the whole, *App.* 463–465——Conviction expressed by Captain Mercer as to the decided superiority of rifled over smooth-bored guns, *ib.* 463, 464.

Mersey Iron. Reports by the Ordnance Select Committee in 1862 upon 70-pounder and 40-pounder Armstrong guns made from blocks supplied by the Mersey Steel and Iron Company, *App.* 368–370.

Monroe, Fort. Reference to the character of the guns and projectiles in Fort Monroe, *Ewart* 4558–4561.

Monsell, Mr. Draft Report proposed by Mr. Monsell as Chairman of the Committee; adoption thereof, with sundry amendments, *Rep.* xvii–xxi. xxiv–xxxi.

Moorsom's Shells. Report of Captain Seymour relative to the practice with Moorsom's shell from the "Miranda" and "Harrier" at Sydney, on 5th March 1862, *App.* 469.

MUZZLE-LOADERS:

1. *Relative Advantages, Generally, of Muzzle-loaders and Breech-loaders.*
2. *Merits of the Armstrong Muzzle-loader or Shunt Gun.*

1. *Relative Advantages, Generally, of Muzzle-loaders and Breech-loaders:*

Evidence as to the respective advantages of muzzle-loaders and breech-loaders for guns of position, *Gardner* 51–56. 110, 111——Value attached to a muzzle-loader gun and an iron shot for general purposes, *ib.* 83, 84——Important advantages of muzzle-loaders, so that a rifled muzzle-loader is much wanted for the Navy, *Coles* 1620–1622——Accident or danger respectively in muzzle-loading and breech-loading; advantage of the former hereon, *Sir R. Dacres* 2203; *Cochrane* 2262–2277; *Scott* 4426–4429——Approval of an extensive use of muzzle-loaders, *Seymour* 2331.

Advantage of witness's system of rifling in its being equally applicable to both breech-loading and muzzle-loading, *Whitworth* 2463——Much greater simplicity of the muzzle-loader, whilst it can be loaded and fixed as quickly as the other, *ib.* 2464, 2465——Preference on the whole for muzzle-loading guns, if they can secure the same range and accuracy as breech-loaders, *Tulloh* 2823–2826.

Considerations as to the advantages, generally, of muzzle-loaders and of breech-loaders; witness is no blind partisan of the latter, *Sir W. Armstrong* 3167. 3266. 3496.

Conclusion as to the old Whitworth muzzle-loader not being a safe gun on account of the tendency of the shot to get jammed in the bore, *Hewlett* 3309–3317. 3336–3338. 3344–3346. 3395–3412——Preference given to the muzzle-loading guns if their safety could be secured, and if the projectiles could be sent well into the bore after continuous firing, *ib.* 3318. 3333–3339——Preference in the Navy for muzzle-loaders, *Scott* 4425——Of 300 muzzle-loaders for the Navy, in 1861–62, 200 were to be made at Woolwich and 100 at Elswick, but the principle of construction was not determined upon, *Baring* 5241, 5242——The money taken in 1861–62 for muzzle-loaders was in reality spent upon the larger Armstrong guns, the experiments with the muzzle-loaders not being conclusive, *ib.* 5243.

Conclusion of the Committee as to there being a preponderance of opinion in favour of muzzle-loading for large guns, *Rep.* viii.

Report, 1863—*continued.*

MUZZLE-LOADERS—continued.

2. *Merits of the Armstrong Muzzle-loader or Shunt Gun:*

Advantages of the Armstrong shunt gun, or muzzle-loader, over the breech-loader, as much less likely to get out of order, *Gardner* 34. 91-98——Objection to the Armstrong muzzle-loading gun as compared with other systems of muzzle-loading, *Sir W. Wiseman* 198, 199——Defect of the Armstrong muzzle-loader, as well as the Whitworth gun, in its requiring careful washing and drying, *ib.* 269-271——Obstacle to using the Armstrong guns in the Navy as muzzle-loaders, *Coles* 1609. 1643.

Steps taken by witness in 1859 towards applying a system of muzzle-loading to large guns; hence the shunt system, which has since been approved by the Ordnance Select Committee, *Sir W. G. Armstrong* 3163——Description of the shunt system, and of its advantages, *ib.* 3163-3166——The object of the system was to afford the means of easy loading from the muzzle, combined with the advantages of a tight-fitting projectile coming out of the bore; how this object has been attained, *ib.*

Witness does not commit himself to any blind adherence to what he has already accomplished, and is giving his anxious attention to the attainment of greater simplicity and increased efficiency, *Sir W. G. Armstrong* 3266——When his shunt system shall have been perfected, it will be for the authorities to decide between the breech-loader and the muzzle-loader, each of which has its advantage, *ib.*——Witness is now giving his very best attention to his shunt gun, *ib.*

Approval of the principle of the Armstrong shunt muzzle-loader; good results anticipated from this gun, *Hewlett* 3319-3323. 3335-3339. 3380-3382. 3423-3429——Increased penetrating power, combined with safety, to be secured by the shunt gun, if spherical shot and increased charge be used, *ib.* 3423-3427.

From experiments with his shunt gun, witness is led to expect equal range and accuracy, without any of the disadvantages attributed to the breech-loader, *Sir W. G. Armstrong* 3500, 3501.

Statement as to the 300-pounder shunt gun at Shoeburyness having failed in the muzzle after a small number of rounds, *Scott* 4352-4356.

Explanation relative to the requisition by the Admiralty for two wrought-iron shunt guns; doubt whether these have been finally passed by the Ordnance Select Committee, *Duke of Somerset* 5115, 5116.

Reports from the Ordnance Select Committee, in 1862-63, on Armstrong muzzle-loading guns, constructed on the shunt principle, *App.* 347-350.

Remarks by Captain Scott upon the advantages of the shunt gun over the service gun; serious drawbacks, however, in the case of the former gun, *App.* 582, 583.

Reference by the Committee to the attempt, by means of the shunt system, for having muzzle-loading guns rifled without mechanical fitting projectiles, as being still an experiment, *Rep.* viii.

See also *Breech-loaders. Navy, The. Rapidity of Fire. Three Hundred-Pounders. Vent-Pieces.*

N.

NAVY, THE:

1. *Circumstances connected with the Introduction of the Armstrong Gun; part taken in the Matter by the Admiralty and by the Ordnance Select Committee.*
2. *Details of Experiments with Armstrong and Whitworth Guns.*
3. *Merits of the Armstrong Breech-loader for Naval Purposes; its Advantages relatively to the Muzzle-loader and Smooth-Bore.*
4. *Cupola Ships of Captain Cowper Coles.*
5. *Iron-plated Ships; relative Advantages of Rifled Guns and of Smooth-Bores, and of Armstrong and Whitworth Guns.*
6. *Concurrence of Opinion in Approval of a certain proportion of Armstrong or other Rifled Guns.*
7. *Blakely Guns.*
8. *Suggested Special Armaments for Special Work.*
9. *Supply being provided of Large Smooth-bored Guns.*
10. *Question generally as to the Size and Character of the Gun best suited for the Navy.*
11. *Objection to the Supply resting directly with the Admiralty.*

1. *Circumstances*

Report, 1863—*continued.*

NAVY, THE—continued.

1. *Circumstances connected with the Introduction of the Armstrong Gun; part taken in the Matter by the Admiralty and by the Ordnance Select Committee:*

Statement as to the larger Armstrong guns having been recommended for adoption in the Navy and in fortresses by a Committee, of which witness was a member, and which also comprised Sir W. Armstrong and Captain Noble, *Sir W. Wiseman* 160–173. 188–190.

Witness was only called upon to produce guns that should prove efficient against such ships and forts as then constituted the navies and defences of other countries, *Sir W. G. Armstrong* 3226.

Explanation as to the witness having recommended the introduction of the Armstrong gun into the Navy, for which introduction the Admiralty rather than the War Office are responsible, *Hewlett* 3355–3375——In January 1859, witness recommended that the 20-pounder and 12-pounder guns should be introduced for boat service, *ib.* 3359, 3360.

Examination as to the number and character of the experiments made previously to the orders for large numbers of the 110-pounder for the Navy, *Sir W. G. Armstrong* 3547–3559——With regard to the question of the propriety of so large an expenditure on Armstrong guns, witness considers that too large a number of 110-pounders were made, whilst the vent-pieces were yet unsatisfactory, *Jerningham* 3656–3679. 3686–3689. 3974.

Consideration of the question whether the introduction of the gun into the Navy did not rest with the Admiralty, and whether they, rather than the Ordnance Select Committee, are not responsible for such introduction, *Scott* 4181 *et seq.*——Erroneous system in having military men to decide upon guns adopted for the Navy, *ib.* 4267. 4270.

Further evidence as to the part taken by the Admiralty in the introduction of the Armstrong gun into the Navy; question hereon as to the accuracy of witness's view that naval officers have not been sufficiently consulted in the matter, *Scott* 4312–4323. 4363–4374——Reference to the circular issued by the Admiralty to the Navy in October 1861, relative to the experiments made with the 110-pounder, *ib.* 4382–4384. 4437, 4438.

With regard to the introduction of the larger Armstrong guns for the Navy, this was not decided upon till after General Peel had left office, *Earl De Grey and Ripon* 5044–5049. 5059, 5060. 5065, 5066.

Responsibility of the Admiralty for the guns introduced into the Navy, it being necessary, however, to obtain all supplies from the War Department, *Duke of Somerset* 5094, 5095. 5142——Difficulty in regard to the introduction into the Navy of any gun not sanctioned by the War Department, no gun having been adopted which had not been passed by the Ordnance Select Committee, *ib.* 5094–5096. 5142–5153——Circumstance of one of the members of the Ordnance Select Committee being a naval officer, appointed by the Admiralty, *ib.* 5097, 5098. 5144–5147——There is also a naval officer in the War Department who conducts all the correspondence with the Admiralty relative to requisitions for guns, *ib.* 5099. 5148–5150.

Statement showing that when witness entered upon his present office, in July 1859, he had before him reports condemnatory of almost all the guns then known, except the Armstrong gun, which was reported upon most favourably, *Duke of Somerset* 5100——Application by the Admiralty to the War Department, in July 1859, for some 40-pounder Armstrongs, *ib.*——Frequent communications between witness and the late Lord Herbert, in 1859 and 1860, relative to the adoption of an Armstrong 70-pounder or 100-pounder, for naval purposes, *ib.* 5100–5102——Difficulty in obtaining a satisfactory muzzle-loading gun, so that witness in applying for the Armstrong-gun was so far obliged to adopt the breech-loading principle, *ib.* 5100, 5101. 5195–5203.

Information relative to the several requisitions made from time to time by the Admiralty for Armstrong guns; the last requisition was in November 1862, for two 110-pounders on the shunt principle, *Duke of Somerset* 5106–5115——Requisition made by the Admiralty in February 1861, for 200 Armstrong 110-pounders; data by which they were guided in making so large a demand, *ib.* 5106–5108. 5110–5114——Statement as to the Admiralty having in October 1862 declined to receive any more 110-pounder Armstrongs, *ib.* 5114.

Further statement as to the Admiralty relying very much upon the War Office experiments in making requisitions for guns; instances, however, of the War Department having been asked specially to make Navy guns, *Duke of Somerset* 5142–5154——The only Armstrong gun for the Navy included in the War Office Estimates for 1859–60, was a 70-pounder Armstrong gun, *ib.* 5163–5167——Although the Admiralty are responsible for the natures of the guns ordered, they could not act altogether independently of the War Office, *ib.* 5168–5175. 5195——The Armstrong guns had been tried in the Navy

Report, 1863—*continued.*

NAVY, THE—continued.

1. *Circumstances connected with the Introduction of the Armstrong, &c.*—continued.

and thought very highly of, before the Admiralty made the requisitions of July 1859 and February 1861, *Duke of Somerset* 5172–5180——Experiments chiefly, or entirely, with the 40-pounders, before the adoption of the 110-pounders, *ib.* 5177, 5178——Total of 635 110-pounders issued, or in store, which is not too many, *ib.* 5182.

Constant pressure by the Admiralty in 1860 for rifled guns, they eventually having made a large requisition in February 1861, before the framing of the Ordnance Estimate, *Baring* 5234–5239——Large amount of the Ordnance Estimates for 1861–62, the Navy demands having been for 1,200 guns of different classes, and for 300 muzzle-loaders, *ib.* 5235–5240.

Letter from the Admiralty to the Under Secretary of State for War, dated 24th November 1860, objecting to the introduction of cast-iron guns rifled and strengthened, as in the French Navy, *App.* 553.

Reference to the circumstances connected with the adoption of the Armstrong gun in the Navy, *Rep.* v——Approval in September 1859 of the pattern of the Armstrong 40-pounder for the naval service, *ib.*——First extension of the Armstrong system to guns of 110-pounder calibre, in October 1859, *ib.*

2. *Details of Experiments with Armstrong and Whitworth Guns:*

Return from Her Majesty's Ship "Cambridge," of the experimental firing from on board that vessel, &c. with the several Armstrong guns, showing the results of the practice and the different defects or accidents produced in the guns, *App.* 309–319.

Return from Her Majesty's Ship "Excellent," of trials of rifled ordnance, since 1st January 1858, showing in detail the working of and the results obtained by Armstrong and Whitworth guns and projectiles of different natures, *App.* 408 *et seq.*

Result of experiments in January 1861, on board the "Stork," at Spithead, from a Whitworth 80-pounder breech-loading gun, in order to test its suitableness both as a breech and muzzle-loading naval gun, *App.* 434, 435.

Report by Captain Hewlett, dated 4th February 1861, on the trial of Whitworth cannon on board the "Excellent," and showing several objections to the introduction of this gun into the Navy, *App.* 554.

3. *Merits of the Armstrong Breech-loader for Naval Purposes; its Advantages relatively to the Muzzle-loader and Smooth-bore:*

Belief that the Navy, generally, approve of the Armstrong breech-loading gun, *Sir W. Wiseman* 184, 185——Advantage of breech-loaders for the Navy, *ib.* 195.

Inconvenience experienced in the experimental firing of two 110-pounder Armstrongs on board the "Hazard;" no vent-pieces were broken, *Coles* 1565–1568——Objection to the Armstrong gun for naval purposes, not only on account of the liability of the vent-pieces to break, but on account of the complicated character of the gun as a breech-loader, *ib.* 1569–1581. 1601–1610. 1619–1643——Witness would infinitely rather go into action with an armament of 68-pounders than of Armstrong 110-pounders, especially against iron ships, *ib.* 1611–1613.

For a naval action, witness would prefer a large proportion of 68-pounders as compared with the heavy Armstrong guns, *Earl of Lauderdale* 2143–2146. 2166–2168——Several objections to breech-loaders, as compared with muzzle-loaders, for use in the Navy, *Earl of Lauderdale* 2144, 2145. 2159, 2160; *Cochrane* 2262–2277; *Seymour* 2299. 2322–2333——Witness considers the Armstrong gun, or any other breech-loader, is decidedly unsuitable for the Navy, *Seymour* 2299–2322.

Difficulty of depending upon the Armstrong gun at sea, when there is much motion, *Admiral Dacres* 3177–3181——Witness however strongly approves of some rifled guns for ships of war, and would prefer muzzle-loaders to breech-loaders if they could be rendered equally durable, which he doubts, *ib.* 3198–3215——Improbability of naval actions being decided at long ranges, 3218–3220——Doubt as to breech-loading being particularly objectionable at night quarters, except in as far as the vent-piece is likely to give way, *ib.* 3221–3224.

Witness has had much experience of all natures of Armstrong guns, and entertains a very high opinion of them with respect to range, accuracy, and perfect safety, that is, with common care, *Hewlett* 3272 *et seq.*——The chief defect of the gun arises from the vent-pieces which, in the heat of action, might not always be properly screwed up, *ib.* 3273. 3331. 3384——Favourable opinion entertained by witness of the Armstrong naval guns from his first experience of them, *ib.* 3303–3308——The gun is neither complicated nor unsafe; prejudice against it in the Navy on this score, *ib.* 3331. 3418–3422. 3432, 3433.

Explanation as to some casualties with the 110-pounder guns, reported in December last, not being in any way owing to witness's system of construction, *Sir W. G. Armstrong* 3568–3572.

Checks

Report, 1863—*continued.*

NAVY, THE—continued.

3. *Merits of the Armstrong Breech-loader for Naval Purposes, &c.*—continued.

Checks have been constantly experienced by witness in his practice with the Armstrong gun on account of deficiency in some of the fittings, *Jerningham* 3626. 3723-3732——Great value of the 110-pounder if the defect in regard to the vent-piece can be obviated, *ib.* 3633-3637. 3662. 3703. 3754-3757——Great care necessary in the use of the Armstrong gun; doubt as to the gun being particularly objectionable on this score during the heat of action, *ib.* 3648-3653. 3754-3766.

Doubt as to the expediency of such large orders for 110-pounders, whilst the vent-pieces were so unsatisfactory, *Jerningham* 3656-3679. 3686-3689. 3794; *Wainwright* 3811, 3812——Dissatisfaction and prejudice in the Navy in regard to the larger Armstrong guns, on account of the defects in regard to vent-pieces, &c., *Jerningham* 3688——Favourable opinion entertained of the new weapon by those instructed in gunnery ships, *ib.* 3688. 3704.

Anticipation that in course of time the prejudice against rifled guns will disappear, and that they must eventually be adopted, *Jerningham* 3705-3708——Great advantage of the rifled guns and projectiles against wooden ships, *ib.* 3744——In general action in rough weather, witness would however prefer on the whole the smooth-bore gun, *ib.*

Witness would be very sorry to see the gun introduced generally into the Navy, *Wainwright* 3771 *et seq.*——Much too complicated character of the gun, as compared with the smooth-bore gun, for use in close action; very prejudical effect of any accidents under such circumstances, *ib.* 3783. 3794-3797——Special class of trained men required for the rifled breech-loader, *ib.* 3799-3801——Witness prefers the old smooth-bore to the rifled gun, in general action as well as against forts and rifled plates, *ib.* 3802-3810.

Total of only nine 110-pounders returned for repairs out of the total number issued, *Sir W. G. Armstrong* 3879-3883.

Witness considers that the expenditure on the Armstrong naval gun was not wisely incurred, *Scott* 4114 *et seq.*——Enumeration of the main objections to the larger guns for naval purposes, *ib.* 4116——Respects in which the Armstrong gun is objectionable as a chase gun, *ib.* 4129-4132——Examination to the effect that witness objects only to the gun adopted for the Navy, and does not find fault with the Ordnance Select Committee for having recommended the smaller guns as field pieces, *ib.* 4173-4180.

Expediency of further experiments having been made with the Armstrong and other guns before so large an expenditure was incurred so extensively for the Navy, *Scott* 4195-4216——Fault in the authorities in not having attempted to procure for the Navy a rifle gun capable of firing the round shot already in use, *ib.* 4207-4212——Unfitness of the Armstrong gun for naval purposes although it may be very good at target practice, *ib.* 4371-4385——Preference in the Navy for muzzle-loaders, *ib.* 4425.

The 68-pounder smooth-bore is the best gun at close quarters, and future actions are likely to be settled at close quarters, *Ewart* 4573-4576. 4579-4583——Enormous expenditure incurred without the production of any gun, in general use in the Navy, sufficiently powerful to operate against iron-clad ships, *Blakely* 4607-4609.

Opinion that the Armstrong 110-pounder, although possessing some great advantages, has not proved entirely satisfactory for the naval service, *Duke of Somerset* 5102——Doubt expressed by witness in 1860 as to the 110-pounders being found effective for broadside purposes; subsequent experience has tended to confirm this opinion *ib.* 5102. 5118-5123——Statement that at present there is no better gun than the 68-pounder at close quarters, *ib.* 5108, 5109. 5121-5123——All the Armstrong guns hitherto supplied to the Navy are capable of improvement, *ib.* 5181——Approval of the Armstrong 100-pounder on board the "Excellent" and "Cambridge," as a gun between decks, except that there was some objection to the smoke, *ib.* 5207-5212——Use of fewer 100-pounders than was intended, on account of their power being less than was expected, *ib.* 5215.

Hasty construction of the first 100 of the 100-pounder guns, before any experiments upon them had been concluded, *Rep.* v——Conclusion as to the defective character of the 110-pounder in certain respects, although it is considered by naval men of eminence and by the Duke of Somerset that the present proportion of these guns in the Navy is satisfactory, *ib.* vii.——Advantage of the 68-pounder as compared with the 100-pounder for close quarters, *ib.*

4. *Cupola Ships of Captain Cowper Coles:*

Much more rapid firing from a gun in a cupola on board the "Trusty" than from a broadside gun, *Coles* 1555-1559——Very heavy gun contemplated by witness in connexion with his cupola system, *ib.* 1623-1629——Advantage of breech-loaders in turreted ships, *Earl of Lauderdale* 2161.

NAVY, THE—continued.

4. *Cupola Ships of Captain Cowper Coles*—continued.

Particulars of trials, in February and March 1862, of Captain Coles' shield, fitted to contain two 100-pounder Armstrong guns, in order to ascertain whether the guns could be worked satisfactorily; favourable results obtained, *App.* 447-449——Further trial of Captain Coles' model of shield for two 100-pounders, showing the amount of recoil under different circumstances, *ib.* 451.

5. *Iron-plated Ships; relative Advantages of Rifled Guns and of Smooth-bores, and of Armstrong and Whitworth Guns:*

Result of the experiments with the Armstrong and Whitworth gun against the iron target; greater effect of the latter as regards the "Warrior" target, *Gardner* 57-62. 99——More damaging effect at short range of the 68-pounder than of the Armstrong 110-pounder against iron-plated ships, *Coles* 1576. 1583-1585. 1611-1613. 1633-1640; *Cochrane* 2237.

Reference to the fact of witness's four-ton gun having penetrated plates where the service four-ton gun failed to do so; this was due to the temper of the shot, *Whitworth* 2006. 2021-2030. 2046-2050——Explanation as to the mode of construction and the performances respectively of two guns made for witness at Woolwich and of two guns made at Manchester; it was one of the former guns that was found so successful against iron plates, *ib.* 2053-2071——Reference to a statement by the Ordnance Select Committee that spherical shot would be most effective against iron-plated ships at very short distances, *ib.* 2350-2353——Different guns of witness which have been used against plated targets at Shoeburyness, and important results obtained, *ib.* 2439.

With regard to the powers of witness's gun to pierce armour-plates, it is not even yet decided what the thickness or strength of plates artillerists may be called on to penetrate, nor is it at all determined what the capability of ships for carrying heavy guns shall be, *Sir W. G. Armstrong* 3225——Everything was uncertain as to the plating of ships when witness designed his gun, *ib.* 3225, 3226——There are experimental guns that could pierce the "Warrior" target at 1,000 yards, but no such guns are in the service, nor is it reasonable to expect that there should be, *ib.* 3226——Several experimental or pattern guns which witness has now completed for the purpose of dealing with armour-plated ships, forts, or casemated defences, *ib.* 3226, 3227.

Favourable opinion of the Iron Plate Committee in regard to witness's 300-pounder muzzle-loading gun of twelve tons, *Sir W. G. Armstrong* 3227——Grounds for concluding that it will be necessary to use guns of a very large calibre in order to destroy armour-plated ships, *ib.*——Opinion that nothing less than a bore of nine inches will be adequate for this purpose, *ib.*

Inferiority of the rifled breech-loader, as compared with the smooth-bore, for the penetration of iron plates, on account of the less initial velocity of the rifled gun, *Jerningham* 3646, 3647. 3694-3700——It would, however, be useless to employ the 68-pounder against iron plates at a greater distance than 200 yards, *ib.* 3695.

Circumstance of an experiment in the autumn of 1860 having shown that the Armstrong 80-pounder was inferior to the 68-pounder smooth-bore gun against iron plates, *Scott* 4116. 4122-4125——Inferiority at the present time of the Armstrong naval gun, as compared with the smooth bore, against plated ships, *ib.* 4124-4128——Circumstance of the Horsfall smooth-bore gun having pierced iron plates at a distance of 800 yards; great weight of this gun, *ib.* 4163-4167.

Risk incurred respectively by iron and wooden ships in passing by a battery of Armstrong guns at 1,000 yards, *Ewart* 4594-4598——Great danger to an iron-plated vessel if penetrated by a shell, *ib.* 4599-4603.

Enormous expenditure incurred without the production of any guns, in general use in Navy, sufficiently powerful to operate against iron-clad ships, *Blakely* 4607-4609——Immense expenditure in the construction of an iron-clad fleet, which after all is incapable of resisting the powerful ordnance of France, *ib.* 4609-4611——Letter from witness to the Duke of Somerset in October 1860, offering to supply at his own cost a gun capable of penetrating iron-plated ships, *ib.* 4760——Every gun not capable of penetrating iron-plated ships should be rejected, *ib.* 4814. 4821——Witness considers the 68-pounder smooth bore quite ineffective against iron-plated ships, *ib.* 4821-4822.

Now that iron ships are being so extensively introduced, the Armstrong gun is not sufficiently powerful at short ranges, *Duke of Somerset* 5102. 5108. 5121-5123——Reference to the success of a Whitworth gun in piercing a 4½-inch plate of the "Trusty," *ib.* 5154. 5183. 5193.

Return from Her Majesty's ship "Excellent" in October 1858, containing details of trials with the Whitworth 68-pounder in order to ascertain its effects against iron plates, *App.* 416, 417.

Particulars

Report, 1863—*continued.*

NAVY, THE—continued.

5. *Iron-plated Ships; relative Advantages of Rifled Guns, &c.*—continued.

Particulars of trials, in August and September 1861, with the 100-pounder Armstrong gun against an angular target composed of rolled iron, &c. of different thicknesses, &c., *App.* 440–443.

Record of all trials at Shoeburyness with Armstrong rifled 300-pounder guns against iron plates, with full particulars as to the results obtained, *App.* 521–523.

Conclusion of the Committee that the old 68-pounder is the most effective gun in the service against iron plates, *Rep.* vii.

6. *Concurrence of Opinion in Approval of a certain proportion of Armstrong or other Rifled Guns:*

For long-range fighting and as chase guns there should be some rifled guns in each ship, *Coles* 1585–1587. 1637–1640——Although witness entertains several objections to breech-loaders as compared with muzzle-loaders, he approves of a certain proportion of rifled breech-loaders, *Cochrane* 2262–2277——Approval of the proportion of eight Armstrong guns on board 80-gun ships, or one in ten, *Admiral Dacres* 3174, 3175. 3198–3215.

Witness approves of the present limit to the proportion of Armstrong guns on board men-of-war, on account of the many advantages possessed in other ways by smooth-bore guns, *Hewlett* 3273–3275——Approval also of the arrangement of placing Armstrong guns exclusively on the upper deck, and of having also three or four of these guns between decks as chase guns, *ib.* 3275——Approval of the Armstrong gun being retained on the main deck, on account of its great range, and the destructiveness of the shell, *Wainwright* 3771. 3783. 3789.

Opinion that one Armstrong gun in five is as much as there should be on board a man of war, *Ewart* 4554, 4555. 4569——Although the Armstrong guns are too complicated for quick firing in close action, they are very desirable as chase-guns, and for bombarding at a distance, *ib.* 4570. 4577. 4588.

Reports of officers in command of ships adverted to as not approving generally of the Armstrong gun between decks, but as favourable to it upon the upper deck as a pivot-gun or chase-gun, *Duke of Somerset* 5118–5121——Opinion that with respect to wooden ships and our naval power in all parts of the world, there are not any too many 110-pounder Armstrong guns in the service, *ib.* 5156, 5157. 5182.

Certain defects in the 110-pounders, or 100-pounder, whilst the present proportion of these guns in the Navy is however approved of, *Rep.* vii.

7. *Blakely Guns:*

Remarks upon the similarity between witness's gun and the 100-pounder Armstrong adopted in the Navy, *Blakely* 4788. 4867–4873——The 9-inch gun made by witness weighs about 10 tons, and there is no difficulty in using it in the Navy, *ib.* 4813——The largest gun made by witness is one weighing 27 tons; a ship might carry two of these, *ib.* 4815–4821.

With regard to Captain Blakely's gun, witness had no such experience of it as would would justify him in requesting the War Department to provide it, *Duke of Somerset* 5105.

8. *Suggested Special Armaments for Special Work:*

Expediency of guns of a special kind being used in arming ships for special work, such as an attack on forts, *Earl of Lauderdale* 2163–2167.

9. *Supply being provided of Large Smooth-bored Guns:*

Desire expressed by the Admiralty in October last for twenty 150-pounder smooth-bore guns; some of these are now being provided, *Duke of Somerset* 5114. 5129.

10. *Question generally as to the Size and Character of the Gun best suited for the Navy;*

Objection to larger guns than 100-pounders on board men-of-war, *Admiral Dacres* 3196, 3197——Contemplated use on board ship of guns of greater weight than six tons, *Sir W. G. Armstrong* 3227——Opinion that both the 32-pounder and the 68-pounder are too small for future naval purposes, *Blakely* 4811, 4812——Very large guns contemplated for future warfare, *ib.* 4813–4821.

Witness would like a gun, either smooth-bored or rifled, which could fire about 25 lbs. of powder and a projectile of about 150 lbs., *Duke of Somerset* 5103——Considerable investigations and experiments still necessary in order to arrive at the best gun for the Navy, *ib.* 5109. 5219–5218——Such is the uncertainty still on the subject of naval ordnance, that witness does not know which gun is best, *ib.* 5216–5218.

Report, 1863—*continued.*

NAVY, THE—continued.

11. *Objection to the Supply resting directly with the Admiralty:*

Disapproval of the guns for the Navy being provided separately by the Board of Admiralty, *Duke of Somerset* 5155.

See also *Accuracy* (*Rifled and Smooth-bore Guns*). *"Black Prince," H. M. S. Breech-loaders. Carriages* (*Armstrong Guns*). *Forty-pounder Armstrong Guns. France. Fuzes. "Harrier," The. Initial Velocity. "Melpomene," H. M. S. One hundred-pounders or* 110*-pounders. Projectiles or Shells. Range of Guns. Ricochet Firing. Smooth-bore Guns. Submarine Gun. Vent Pieces. Wads. "Warrior," H. M. S. Whitworth Guns and Projectiles.*

Needham, Mr. Statement as to Mr. Needham, the manager of the Butterley Company, having, on seeing the process of manufacture at the Arsenal, said that it was precisely similar to the method adopted in 1855 for the Blakely gun, *Blakely* 4627. 4676.

New Zealand. Statement as to the want of accuracy of three Armstrong guns used by the Royal Artillery in action in New Zealand; favourable opinion entertained of these guns by Captain Mercer, of the Artillery, *Seymour* 2301–2304. 2308–2316. 2339–2349.

Copies of reports received from Captain Mercer respecting the Armstrong gun in New Zealand, showing the results of practice with the gun and the defects experienced on the score of breech-screws, vent-pieces, &c.; destructive effects produced by the gun, *App.* 463–465.

Statement by Captain Seymour as to two vent-pieces having been blown out of the Armstrong guns belonging to Captain Mercer's battery, between April 1860 and March 1861, *App.* 469.

Nine-pounders (*Armstrong Guns*). Statement as to its having been officially reported by the commanding officer of Horse Artillery, that out of sixty-five Armstrong 9-pounders only ten are really effective, *Sir R. Dacres* 2173. 2182, 2183.

Highly satisfactory practice with the two batteries of 9-pounders at Dublin, *Sir W. G. Armstrong* 3846——Return of only one 9-pounder for repair, sixty-six being issued and in use, *ib.* 3862.

Report by Ordnance Select Committee in January 1862, relative to certain trials with Armstrong 9-pounders, showing the results obtained and the defects requiring amendment, *App.* 340, 341.

Total number of 9-pounders made in the Royal Gun Factory, distinguishing between the number made and issued for service and the number made but not yet issued, *App.* 380.

Report of the trial of a 9-pounder Armstrong gun on board the "Excellent," in order to ascertain its advantages as an armament of barges and pinnaces, and also for field service, *App.* 450.

Total of sixty-six 9-pounder Armstrong guns issued up to February 1863, all having been made as the Royal Gun Factory, *App.* 530.

Monthly and quarterly diaries of officers commanding batteries of 9-pounder Armstrong Guns, since such were first issued to the Royal Artillery, explanatory of the practice with the guns, and of their advantages and defects, *App.* 566–581.

Noble, Captain Andrew. (Analysis of his Evidence.)—Was secretary to the Committee on Rifled Ordnance, which decided upon the introduction of the Armstrong gun into the service; was present at all the trials up to a certain date, 3079, 3080—— The Whitworth gun was tried eight or nine times, and the Armstrong gun about fifty times, 3081–3085——Mr. Whitworth was present at trials when diagrams of his gun were made, 3086–3090. 3133——Due notice of the trials of his gun was always given to Mr. Whitworth, and he was afforded every facility to be present; in point of fact, he was present at nearly all the trials, 3087–3104. 3126–3131. 3133——The records of the Committee would not show upon what occasions Mr. Whitworth was present, or that previous notice was given to him, 3091–3095——The Committee rigidly adhered to the rule that no inventor should be present at the trial of another inventor's gun, 3098.

The reason Mr. Whitworth's gun did not receive the same extended trial as the Armstrong gun was, that he only provided shot and common shell without fuses, whereas Sir W. Armstrong had a perfect fuse and shrapnel shell, 3105–3115——At this period Mr. Whitworth had not a gun of his own construction, but had merely rifled Government blocks of brass and cast iron, 3105——Fuses might in time have been proposed by Government for the Whitworth shell, with a view to a more perfect trial; but it was not the province of the Committee on Rifled Ordnance to undertake this matter, 3106–3115. 3122–3125.

The Armstrong gun was adopted in preference to the Whitworth gun as having proved superior to it on all points in which the two were compared, 3116–3121——No programme of the proceedings of the Committee was ever furnished to any competitor, 3131——The

Report, 1863—*continued.*

Noble, Captain Andrew. (Analysis of his Evidence)—*continued.*

——The guns were fired and worked entirely by artillerymen, 3131——The Committee had no personal feeling whatever in favour of Sir W. Armstrong's gun, and were completely unanimous in recommending it as the best, 3131, 3132.

Explanation upon the question of one shot with the Whitworth gun which fell very short of the range, having been included in the calculations; propriety thereof, 3134–3137——Opinion as to the satisfactory character of the Armstrong vent-pieces up to the 40-pounders, 3138, 3139—— Improvement recently in the 100-pounder vent-pieces, 3140 ——Approval of the experiment made with the lined guns; these guns are not a fair test of Sir W. Armstrong's principle, 3141–3148——Use of homogeneous metal in the barrel of the first gun made by Sir W. Armstrong, 3149——Advantage of homogeneous metal being now extensively used, but only for the barrel or centre of the gun, 3149–3152 ——Impression that two 25-pounder guns made at Elswick and found faulty were subsequently lined there, 3153–3155.

O.

Obsolete Patterns. Views of the Duke of Cambridge as to the absolute necessity for not allowing articles of stores to be used of patterns which have been found in practice to be faulty, *App.* 332. *See* also *Projectiles or Shells*, 7.

One Hundred-Pounders, or 110-Pounders (Armstrong Breech-loaders):

1. *Merits of the 110-Pounder considered in connection with its Introduction into the Navy.*
2. *Details of Experiments.*
3. *Cost at Woolwich and at Elswick.*
4. *Number supplied from Elswick and from Woolwich.*
5. *Similarity between this Gun and the Blakely Gun.*

1. *Merits of the 110-Pounder considered in connection with its Introduction into the Navy:*

Inconvenience experienced in the experimental firing of two 110-pounder Armstrongs on board the "Hazard"; no vent-pieces were broken, *Coles* 1565–1568.

Examination as to the number and character of the experiments made previously to the orders for large numbers of the 110-pounder for the Navy, *Sir W. G. Armstrong* 3547–3559——Explanation as to some casualties with the 110-pounder guns, reported in December last, not being in any way owing to witness's system of construction, *ib.* 35-68 3572.

Great value of the 110-pounder if the defect in regard to the vent-piece can be obviated, *Jerningham* 3633–3637. 3662. 3703. 3754–3757——With regard to the question of the propriety of so large an expenditure on Armstrong guns, witness considers that too large a number of 110-pounders were made whilst the vent-pieces were yet unsatisfactory, *ib.* 3656–3679. 3686–3689. 3974.

Total of nine 110-pounders returned for repairs out of the total number issued, *Sir W. G. Armstrong* 3879–3883.

Opinion that the Armstrong 100-pounder, although possessing some great advantages, has not proved entirely satisfactory for the naval service, *Duke of Somerset* 5102—— Doubt expressed by witness in 1860 as to the 100-pounders being found effective for broadside purposes; subsequent experience has tended to confirm this opinion, *ib.* 5102. 5118–5123.

Requisition made by the Admiralty in February 1861 for 200 Armstrong 110-pounders; data by which they were guided in making so large a demand, *Duke of Somerset* 5106–5108. 5110–5114—— Statement as to the Admiralty having in October 1862 declined to receive any more 110-pounder Armstrongs, *ib.* 5114——Total of 635 110-pounders issued or in store, which is not too many, *ib.* 5182.

Approval of the Armstrong 100-pounder on board the "Excellent" and "Cambridge" as a gun between decks, except that there was some objection to the smoke, *Duke of Somerset* 5207–5212——Use of fewer 100-pounders than was intended, on account of their power being less than was expected, *ib.* 5215.

Conclusion as to the defective character of the 110-pounder in certain respects, although it is considered by naval men of eminence, and by the Duke of Somerset, that the present proportion of these guns in the Navy is satisfactory, *Rep.* vii.

2. *Details of Experiments:*

Return from H. M. S. "Cambridge" of the experimental firing from on board that vessel, &c., with the Armstrong 110-pounders, showing the results of the practice and the different defects or accidents produced in the guns, *App.* 317–319.

Reports by Ordnance Select Committee in April 1862 of certain experimental firing with the 110-pounder gun, *App.* 337–339—— Report by Ordnance Select Committee

Report, 1863—*continued.*

ONE HUNDRED-POUNDERS, &c.—continued.

2. *Details of Experiments*—continued.

in April 1862, with reference to the failure of three 110-pounder guns in the proof of vent-pieces, *App.* 339.

Details of experiments on board the "Excellent," &c., *App.* 408 *et seq.*——Particulars of experiment in June 1861 with felt lubricating wads for the 100-pounder gun, *ib.* 437–439——Experiments in June 1860 in order to ascertain the best means of getting rid of the hard scale in the chamber of the 100-pounder; efficiency of a wet sponge for this purpose, in enabling the shot to go close home, *ib.* 439.

Particulars of trials in August and September 1861 with the 100-pounder Armstrong gun against an angular target composed of four plates of rolled iron, &c., of different thicknesses, &c., *App.* 440–443.

3. *Cost at Woolwich and at Elswick:*

The 100-pounder at Elswick was estimated at 600 *l.*, but the real price was 670 *l.*, *Baring* 5247–5249. 5251——Grounds for concluding that the price of 700 *l.*, or rather of 670 *l.*, paid for the 100-pounders first made at Elswick was not excessive, *ib.* 5300–5302. 5316——Varying and unsatisfactory character of the estimates of cost of the 100-pounder, *ib.* 5300. 5311–5316——Impossibility, even at the present time, of saying what the actual cost of the 100-pounder has been, *ib.* 5300——Lower price of the 100-pounder at Elswick in 1861 if as many had been ordered there as at the Gun Factory, *ib.* 5316, 5317.

Conclusion as to the inaccuracy of a calculation by which the cost of the 100-pounder at the Gun Factory is placed at 387 *l.* 10 *s.* 9 *d.*, *Baring* 5326 *et seq.*

Evidence in support of the accuracy of witness's calculations as to the lower cost at Woolwich than at Elswick, *Whiffin* 5575 *et seq.*——Witness cannot find that there was any abatement from the sum of 700 *l.* paid for 100-pounders at Elswick, *ib.* 5642, 5643——Still lower cost per gun at Woolwich if all the 100-pounders had been made there, *ib.* 5702, 5703.

Statement of the amount and rates paid for certain guns to the Elswick Ordnance Company, compared with the original rates assumed in Sir W. G. Armstrong's letter, *App.* 466——Great difference between the actual rates paid and the rates assumed in the letters from Sir W. Armstrong in 1858, the former being only about half the amount of the latter, *ib.* 467.

Statement showing the cost of the 100-pounder guns returned from the Elswick Ordnance Company, compared with the rates of those produced at the Royal Arsenal, Woolwich, *App.* 480.

Statement by the Elswick Company, showing the approximate cost of each of the first 208 110-pounders made in the Royal Gun Factories, *App.* 544 ——Statement as to the superior character of the 110-pounders made at Elswick as compared with the first 110-pounders made at Woolwich, *ib.*——Explanation on the part of the Elswick Company that their price for the first 208 110-pounders was 671 *l.* and not 700 *l.*, *ib.*

4. *Number supplied from Elswick and from Woolwich:*

Total of 261 110-pounder guns supplied by the Elswick Company up to 31 March 1863, including those outstanding, *App.* 379——Total of 79 110-pounders made in the Royal Gun Factory, distinguishing between the number made and issued for service, and the number made but not yet issued, *ib.* 380——Total number of 110-pounders issued up to February 1863, and number made respectively at Elswick and at Woolwich, *ib.* 530.

5. *Similarity between this Gun and the Blakely Gun:*

Statement that the drawings which witness supplied for strengthening the 32-pounder gun represented very faithfully the 100-pounder Armstrong gun afterwards introduced into the service, *Blakely* 4788——Although the 100-pounder Armstrong gun was very similar to a drawing made by witness, it was doubtless planned by Sir W. Armstrong before he had seen such drawing, *ib.* 4867–4873.

See also *Experiments.* *Navy, The.* *Vent-pieces.*

ORDNANCE SELECT COMMITTEE:

1. *As to the Treatment of Inventors by the Committee.*

2. *Reports by the Committee relative to the Armstrong Guns, &c.*

1. *As to the Treatment of Inventors by the Committee:*

Explanatory statement upon the subject of a Report by the Ordnance Select Committee in November last, wherein the personal honour of witness, and the originality of his system of rifling is called in question, *Whitworth* 1099 *et seq.*——Comment upon the unfair mode in which the Committee conducted their investigation; witness was, in fact, condemned unheard, and was not aware until very recently that any report had been made at all, *ib.* 1099. 1102–1121——The Ordnance Select Committee were, in fact, altogether unjustified for reporting that witness made an incorrect assertion in his letter to the "Times" on the 8th November when he said that the seven-inch gun was made according to drawings supplied by himself, *ib.* 1102 *et seq.*

Witness

Report, 1863—*continued.*

Ordnance Select Committee—continued.

1. *As to the Treatment of Inventors by the Committee*—continued.

Witness as an inventor has not hitherto encountered difficulties from the Ordnance Select Committee, but has heard other inventors complain, *Richards* 4027-4029.

Objectionable system pursued by the Ordnance Select Committee in not having required identical conditions when trying the Armstrong and other guns, *Scott* 4117-4122——Examination to the effect that witness objects only to the gun adopted for the Navy, and does not find fault with the Ordnance Select Committee for having recommended the smaller guns as field pieces, *ib.* 4173-4180——Consideration of the question whether the introduction of the gun into the navy did not rest with the Admiralty; and whether they, rather than the Ordnance Select Committee, are not responsible for such introduction, *ib.* 4181 *et seq.*

Probability of the inventions of Mr. Britten and others not having been properly tested, because of a pre-determination in the authorities to make some plan of Sir W. Armstrong successful; official position of Sir W. Armstrong, and functions of the Ordnance Select Committee adverted to hereon, *Scott* 4252-4275——Difficulty, but for the Admiralty, in witness obtaining from the Ordnance Select Committee a trial of his gun, *ib.* 4311——Witness further complains of the manner in which the Ordnance Select Committee tried and reported upon his plan for rifling the cast-iron guns, *ib.* 4323-4351.

Witness further takes exception to the report of the Committee which tried his gun, on account of their treating it as a competitive gun; statement hereon that it was never made to compete, *Scott* 4481 *et seq.*——The system advocated by witness in 1859 is quite different from the Armstrong system, whereas it was classed with it by the Select Committee. *ib.* 4519, 4520——The report of the Committee does him considerable injustice, whilst he has at the same time incurred considerable expense, *ib.* 4526.

Particulars connected with offers by witness in 1860 and 1861, to provide a nine-inch and a twelve-inch gun at his own expense, and to guarantee them and lend them to Government free of charge; complaint as to this offer not having been accepted, without the condition that the drawings should first be submitted to and approved by the Ordnance Select Committee, *Blakely* 4756-4764. 4770-4799. 4867-4880. 4892-4894.

Opinion that inventors generally are not favourably disposed towards the Ordnance Select Committee, *Duke of Somerset* 5145.

2. *Reports by the Committee relative to the Armstrong Guns, &c.:*

Sundry reports from the Ordnance Select Committee in 1862 relative to trials with 110-pounder Armstrongs and with 12-pounders and 9-pounders, *App.* 336-341.

Reports in 1862 from the Ordnance Select Committee on the Armstrong 40-pounder and 70-pounder guns made on the side breech-loading arrangement, *App.* 342-346.

Reports from the Ordnance Select Committee in 1862-63 on Armstrong muzzle-loading guns, constructed on the shunt principle, *App.* 347-350.

Reports from the Committee in 1862-63 on the failure, &c., of Armstrong vent pieces, *App.* 350-355.

Sundry reports from the Ordnance Select Committee in 1862 on Armstrong's fuzes of different kinds, with reference to the defects experienced in their use, and the means of remedying such defects, *App.* 356-363.

Reports from the Committee in 1862, on Armstrong projectiles, with reference more especially to the new method of coating with lead, and to the character of the old pattern round bottom 110-pounder common shells, *App.* 364-368.

Reports from the Committee in 1862 on Armstrong's guns (12-pounder and 40-pounder) made from Mersey iron or from blocks supplied by the Mersey Steel and Iron Company, *App.* 368-370.

Reports from the Ordnance Select Committee in 1862, on Mr. Whitworth's 12-pounder and 70-pounder guns, with reference more especially to the initial velocities of the projectiles, *App.* 371-375.

See also *Armstrong Guns*, 1, 2. *Experiments. Inventors. Navy, The*, 1. *Whitworth Guns and Projectiles.*

P.

Panmure, Lord. Views expressed by Lord Panmure early in 1858, strongly in favour of the introduction of the Armstrong field gun, *Rep.* iii.

Parapet Firing. Drawback in the Armstrong gun being incapable of parapet firing, *Cochrane* 2236.

Patent (*Armstrong Guns*). Witness considers that the Armstrong system could not have been a valid subject to patent in 1858, as he had already used it in 1855, *Blakely* 4657.

Report, 1863—*continued.*

Patent (*Armstrong Guns*)—continued.

4677——Doubt as to what Sir William Armstrong's patent really is, the specification being, under the Act of Parliament, kept secret, *Blakely* 4672-4674. 4688.

Witness does not look upon the patent obtained by Government as any return for the expenditure incurred, which is rather to be measured by the actual working of the system, *Sir W. G. Armstrong* 5010-5012.

Government could not have manufactured the guns without the patent; with it they can prevent manufacture by anyone else, *Earl De Grey and Ripon* 5068-5074——It is provided by Act that the patent may be kept secret, and witness considers it unadvisable to produce it, *ib.* 5075-5081.

Doubt as to its being of much use to keep secret the patent of Sir W. Armstrong, *Anderson* 5555-5559.

Reference by the Committee to the assignment by Sir W. Armstrong of his interest in his patents to Government, and to the refusal of the Secretary of State for War to submit these patents to the Committee, *Rep.* iv.

See also *Coil System.*

Patterns. Manufacture of the greater number of the Armstrong 12-pounders before the sealed pattern was received at the Gun Factory, *Anderson* 543-546——The pattern was sealed on 5 May 1860, the manufacture having been commenced in April 1859, *ib.* 546——Progress made with the 9-pounders and the guns generally before the patterns have been received, *ib.* 560——The sealed pattern only extends to the exterior and the interior, and not to the structure of the gun, *ib.* 561, 562.

Manufacture of guns at Elswick as well as at Woolwich before the sealed pattern was received, *Anderson* 573-575——Exact similarity between the guns made in 1859, and the gun which had been approved by the Ordnance Select Committee, *ib.* 595-598——Variation since 1859 in the sealed pattern of the 12-pounder gun, the principle of manufacture being, however, very much the same, *ib.* 616-619——Further statement on the question of deviation from the sealed pattern, in regard to the bouching or lining, and the general structure of the gun, *ib.* 697-720. 766-793.

Impropriety of the view expressed by Mr. Anderson that he does not consider himself bound to abide absolutely by the sealed pattern, *H. R. H. The Duke of Cambridge* 1229. 1235, 1236.

Practice of Sir W. Armstrong and witness not to make any real deviations from the sealed pattern, and to obtain proper authority for any alterations, *Anderson* 1966-1970——Several changes in the sealed pattern for the field guns, the present sealed pattern being a lined gun, *Gordon* 2129-2134——Information as to the authority upon which witness acted in making alterations from time to time in the sights, &c, of the Armstrong gun; he had not always written sanction, *Anderson* 5439-5461.

Details relative to the changes in the patterns of the vent-pieces, with the authorities for such changes, *App.* 520.

See also *Lined Guns* (*12-pounders*), 1. *Obsolete Patterns. Projectiles or Shells*, 7. *Vent-pieces*, 6.

Peel, General. With regard to the original agreement with the Elswick Company, witness does not impugn the part taken by General Peel in the matter, *Earl De Grey and Ripon* 5043. 5092——It was not decided to adopt the larger guns for the navy until after General Peel had left office, *ib.* 5044-5049. 5059, 5060. 5065, 5066——During Lord Derby's Goverment field guns only had been decided upon, *ib.* 5047. 5065——The agreement with the Elswick Company was in operation when Lord Herbert came into office, *ib.* 5052——General Peel is in no way accountable for the experiments in the case of the larger guns, *ib.* 5059. 4060.

Considerations upon which the Committee are unprepared to impugn the wisdom of the course adopted by General Peel, and followed by succeeding administrations, with respect to the Elswick Company, *Rep.* vi.

See also *Elswick Company*, 1.

Penetrating Power. Statement as to large projectiles having, as compared with small ones, the disadvantage in penetrating power, and the advantage in destructive effect, *Sir W. G. Armstrong* 3225. 3942, 3943——Witness does not contend that bruises produced by large shot upon armour plates are as injurious as holes made by small shot, *ib.* 3942, 3943.

Details of trials with the Whitworth 24-pounder howitzer with reference to its penetrating power through water and through a ship's side, *App.* 408-415——Experiments in 1858 relative to the penetrating of the Whitworth 68-pounder cast-iron gun against iron plates, *ib.* 416, 417——Particulars as to the penetrating power of the Armstrong 32-pounder as tried at sea in February 1859, *ib.* 419.

Result of experiments on January 1861 in order to test the penetrating power of the Whitworth 80-pounder breech-loading gun; important results obtained, *App.* 435——

Particulars

Report, 1863—*continued.*

Penetrating Power—continued.

Particulars of trials in August and September 1861 with the 100-pounder Armstrong gun against an angular target composed of four plates of rolled iron, &c., of different thicknesses, &c., *App.* 440–443.

Conclusion of the Committee as to the old 68-pounder having more penetrating power than the Armstrong 100-pounder at short range against iron plates, *Rep.* vii.

See also *Iron-plated Ships.*

Percussion Hammers. Explanation relative to an item, in a return of the Gun Factory, of 7,178*l.* for percussion hammers for the 110-pounder Armstrong gun; cause of an apparent discrepancy as compared with a return submitted in 1862, *Anderson* 5418–5437.

Pivots (Armstrong Guns). Statements explanatory of the results as regards the pivots of Armstrong guns with which experiments were made on board the "Cambridge," &c., *App.* 322.

Polygonal Rifling. Examination on the question of the polygonal system of rifling having been due to the late Mr. Brunel; witness states positively that when he first experimented with the polygonal system, he had no knowledge of the polygonal rifle constructed for Mr. Brunel, *Whitworth* 1102. 1385–1409. 2445, 2446. 2545–2551. 2602–2610——Slight modification since 1858 in the hexagonal system then submitted by witness to the Ordnance Select Committee, *ib.* 2447–2453——Particular advantages of the polygonal form of rifling, *ib.* 2447. 2454–2463——Necessity of an extra-strengthening of the guns rifled on the polygonal principle, *ib.* 2478–2480.

Examination as to the grounds for witness's objection to the mechanically fitting projectiles as involved in the polygonal system of rifling, *Sir W. G. Armstrong* 3912–3941. 3949–3967——Way in which the system of polygonal rifling and mechanically fitting projectiles involves a much greater amount of friction than the system of a lead-coated projectile, and endangers the stability and endurance of the gun, *ib.* 3925. 3935–3941. 3949–3967——Character of the experiments upon which witness bases his condemnation of the polygonal system of mechanical fitting projectiles, *ib.* 3928–3934. 3949. 3958–3967.

Letter from Mr. Isambard Brunel to the Chairman of the Committee, dated 27 April 1863, enclosing certain correspondence of the late Mr. Brunel, and of Mr. Westley Richards, as establishing the fact that the former had in 1852 conceived the idea of a polygonal rifle, and that Mr. Whitworth had subsequently been in communication with Mr. Richards on the subject, that is, in 1854; *App.* 402, 403.

Letter from Mr. Westley Richards to Mr. Isambard Brunel, dated 30 June 1863, stating that in 1854 Mr. Richards told Mr. Witworth that he had made a polygonal rifle for Mr. Brunel, and fully discussed the idea of this rifle with Mr. Whitworth, but that the latter did not say that he had himself conceived the idea or made a model of a polygonal rifle, *App.* 548.

Port-Fires. In 1856 or 1857 the port-fires in the service entirely failed, *Bingham* 359, 360—— Since 1855 there have been no complaints with regard to port-fires, *Boxer* 898.

Powder. Very dense smoke arising from the peculiar powder used with the Armstrong gun, and serious inconvenience thereby, *Cochrane* 2236. 2240. 2254–2258. 2290——Defect consequent upon the use of a slow burning powder, *ib.* 2236. 2282–2284——Increased strain upon the gun if the ordinary powder were used, *ib.* 2282–2284.

Use of the ordinary service powder for witness's gun, *Whitworth* 2597–2601——Various kinds of powder used with the Armstrong guns; doubt as to the thick smoke being caused by any peculiarity in the powder, *Jerningham* 3654. 3690–3693——The use of slow burning powder with the Armstrong gun does not interfere with accuracy of aim, *ib.* 3733——Bar to accuracy of aim on account of the slow burning powder used with the gun, *Wainwright* 3781, 3782——Character of the powder adverted to with reference to the thickness of the smoke, *Duke of Somerset* 5212–5215.

Prices or Cost of Guns, &c. (Elswick and Woolwich):

Witness has prepared certain statements and calculations, showing the sums paid to the Elswick Company for guns and projectiles, as compared with the cost if supplied by the Royal Gun Factory, *Whiffin* 3073–3077——From one of these statements it appears that, with respect to the sum of 593,275*l.*, part of the amount paid to the Elswick Company, there would have been a saving of about 242,173*l.* if the articles had been manufactured at the Gun Factory; accuracy of this result, *ib.* 3077.

Much higher price which would have been demanded for the first gun produced, but for the guarantee that the contractors should not be losers by the erection of the plant and machinery, *Sir W. G. Armstrong* 4939–4948——Saving of considerably more than the first guarantee of 35,000*l.* by the reduced prices actually charged for the 180 guns ordered in January 1859, *ib.* 4949–4957——There was never any reference to witness in regard to the Elswick prices or the distribution of orders, *ib.* 5013, 5014.

Report, 1863—*continued.*

Prices or Cost of Guns, &c. (*Elswick and Woolwich*)—continued.

Total of 1,404 guns delivered by the end of the financial Year 1861–62, whereas the money voted was expected to cover only 1,357 guns, *Baring* 5244——Estimates in 1861 for the prices or cost of the several classes of guns at Woolwich and at Elswick, *ib.* 5247——For the larger guns made at Elswick, the original agreement as to price was provisional, *ib.* 5250——Willingness expressed by the company to modify the price in the course of manufacture if the guns came out quicker, *ib.*——So far as witness can judge, the Elswick Company have behaved very fairly with regard to the price, *ib.* 5250–5261.

Check invariably exercised through the heads of departments at Woolwich in regard to the Elswick prices, *Baring* 5252–5267——Sir W. Armstrong did not interfere in any way with the prices, *ib.* 5253, 5254. 5258——Provision that in the case of difference with the Elswick Company, there should be a reference as to prices to the Attorney General, *ib.* 5256, 5257——Instances of the prices of the company having been reduced by the War Office, *ib.* 5258, 5259——Instances also of the prices first agreed upon having been reduced by the company themselves, as the manufacture became more perfected, *ib.* 5260, 5261.

Enhanced cost of the guns first produced, both at Elswick and at Woolwich, on account of the experimental character of the manufacture, *Baring* 5261——Statement as to the wholesome check exercised by the operation and the prices of the Elswick Company upon the manufacture at Woolwich, *ib.* 5261–5272——Opinion that the prices paid to the Elswick Company have not been excessive, allowance being made for the amount to be added as profit, *ib.* 5283–5291. 5295——Unfairness of comparing the prices at Elswick during the experimental stage with the prices at Woolwich after the experimental stage, *ib.* 5316–5326——Higher prices of ammunition and projectiles at Elswick than at the Arsenal adverted to as largely explained by experimental and small orders in the former case as compared with the latter, *ib.* 5318–5326.

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2. *Whitworth Projectiles or Shells.*
3. *Round Shot or Spherical Projectiles.*
4. *Experiments on Board the "Excellent," &c.*
5. *Question as to all the Projectiles not having been made at Woolwich.*
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Higher initial velocity obtained with Mr. Bashley Britten's gun in 1859 than with the Armstrong gun, notwithstanding which the former gun was not properly tried, 4217–4249——Experiments now about to be made with the guns of Mr. Britten, Mr. Jeffrey's, Mr. Lancaster, and with witness's gun, 4250, 4251——Probability of the inventions of Mr. Britten and others not having been properly tested, because of a pre-determination in the authorities to make some plan of Sir W. Armstrong successful; official position of Sir W. Armstrong, and functions of the Ordnance Select Committee adverted to hereon, 4252–4275.

Erroneous system in having military men to decide upon guns adopted for the navy, 4267. 4270——Statement relative to the part taken by witness in advocating the rifling of the cast-iron guns in the service, and conclusion as to the strengthening and rifling of these guns not having been tried under the conditions necessary to ensure success, 4275–4295——Exceptions taken to the conclusions upon the subject of rifling, arrived at by the Committee appointed by Lord Herbert to consider the best mode of making the cast-iron guns available; the trial by this Committee of witness's gun, as a rifled gun, was not satisfactory to him, 4296–4310.

[Second

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Scott, Captain Robert A. E., R.N. (Analysis of his Evidence)—continued.

[Second Examination.]—With regard to witness's views in 1859 upon the question of rifling cast-iron guns, his chief object was to render available the existing supplies of ammunition, 4311——In 1860 and 1861 witness publicly expressed his objections to the principle of coil manufacture, *ib.*——Further experiments now being made with a view to strengthening cast-iron guns, *ib.*——Disapproval expressed by witness on more than one occasion of the continuous and extensive manufacture of Armstrong guns, although a limited supply of them was doubtless justifiable, *ib.*

Further statement as to the undue facilities given to experiments with the guns of Sir W. Armstrong as compared with the guns of other inventors, 4311——Greater initial velocity of Mr. Britten's gun than of the Armstrong gun, further adverted to, *ib.*——Difficulty, but for the Admiralty, in witness obtaining from the Ordnance Select Committee a trial of his gun, *ib.*——Further evidence as to the part taken by the Admiralty in the introduction of the Armstrong gun into the navy; question hereon as to the accuracy of witness's view, that naval officers have not been sufficiently consulted in the matter, 4312–4323. 4363–4374.

Witness further complains of the manner in which the Ordnance Select Committee tried and reported upon his plan for rifling the cast-iron guns, 4323–4351——Great importance attached by witness to the use of round shot in naval actions, whereas the Committee which reported upon his plan omitted all reference to this point, 4323, 4324——Witness contends that there have been no sufficient experiments with regard to rifling, and that they have have been carried out under unequal conditions, 4330.

Statement as to the 300-pounder shunt gun at Shoeburyness having failed in the muzzle after a small number of rounds, 4352–4356——Failure of the cast-iron guns rifled on the shunt principle, 4357–4361——Failure at the breech of a 300-pounder smooth-bore gun at Shoeburyness, 4362. 4454–4457——Unfitness of the Armstrong gun for naval purposes, although it may be very good at target practice, 4371–4385——Unsuitable character of the gun for the rough wear and tear of the service, 4377——Reference to the circular issued by the Admiralty to the navy in October 1861, relative to the experiments made with the 110-pounder gun, 4382–4384. 4437, 4438.

Circumstance of the Armstrong gun having been much matured and strengthened by Mr. Anderson, 4386–4390——Statement as to witness having seen several guns at Woolwich in which the inner tubes of coiled iron were defective, 4390–4417. 4430–4435——Decided preference for mild steel or homogeneous iron as the material for the inner tube, 4396–4398——Very serious character of the injury in the case of three of the guns which failed at Shorncliffe, 4418–4421——Doubt as to the vent-pieces for the guns up to 40-pounders being yet successful, 4422–4424.

Preference in the navy for muzzle-loaders, 4425——Facility of loading very quickly from the muzzle, 4426——Danger respectively in muzzle-loading and breech-loading, 4426–4429——Conclusion arrived at by the Admiralty as to the enduring power of the Armstrong 100-pounder, in consequence of the tests applied and satisfactorily withstood, 4436–4438——Very severe test stood by the Krupp 100-pounder steel gun, 4439. 4447——Very severe test also withstood by the 40-pounder of Mr. Naylor Vickers, made from a solid mass of cast steel; cost of this gun, 4439–4449.

Statement as to Krupp's guns being made from steel, cast and hammered, 4450. 4458–4460——Greater danger when a steel gun bursts than when a wrought-iron gun gives way, 4451–4454——Failure of some small steel guns of Krupp tried in 1851, 4461, 4462——Want of proper inducement for the supply of the peculiar kind of steel desirable, or it would have been provided some years ago, 4463–4469——It is now found that the proper quality of steel can be procured, and Mr. Whitworth is adopting this material, as preferable to coiled wrought iron, 4470–4472.

Good prospect of success held out by some cast-iron cylinders, rifled on various systems, 4473, 4474——Statement to the effect that the lead-coated shot in the shunt gun does vibrate, but that the mechanically fitting projectile in the Whitworth gun does not vibrate, 4475–4481——Effect of the lubrication in preventing cohesion or injury by the use of mechanically fitting projectiles, 4477–4480——Importance of the shot being well lubricated, and of a rounded bearing, in order to prevent abrasion and straining as caused by the coated projectile in the shunt system, 4480, 4481.

Witness further takes exception to the report of the committee which tried his gun, on account of their treating it is a competitive gun; statement hereon that it was never made to compete, 4481 *et seq.*——The system advocated by witness in 1859 is quite different from the Armstrong system, whereas it was classed with it by the Select Committee, 4519, 4520——Witness does not advocate any attempt to return to the material of cast-iron for rifled guns, 4524, 4525——The report of the committee does him considerable injustice, whilst he has at the same time incurred great expense, 4526——Opinion that at close quarters it is important to obtain the greatest possible velocity; views of Sir Howard Douglas adverted to hereon, 4527–4531.

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Scott, Captain. Paper furnished by Captain Scott in support of the conclusion that other systems of rifling which possessed many advantages over the Armstrong plan had not been sufficiently tested, and that almost any other system of rifle-grooving would have yielded results superior to the delicate system which has been adopted, *App.* 583, 584——Data adduced in this paper relative to the advantages of Captain Scott's system of rifling, *ib.*

See also *Cast-iron Guns*, 3. *Experiments*, 4.

Segment Shells. See *Projectiles or Shells.*

SEVEN-INCH WHITWORTH GUNS:

1. *Evidence of Mr. Whitworth and Mr. Hulse relative to the Drawings supplied to Mr. Anderson for this Gun, and contending for the origination of the Gun by Mr. Whitworth.*
2. *Evidence of Mr. Anderson, explanatory of the alterations made in the Original Drawings, and contending that the Gun was eventually constructed on the Armstrong Principle.*
3. *Papers and Correspondence in further elucidation of the Proceedings connected with this Gun.*
4. *Damaged state of the Gun.*

1. *Evidence of Mr. Whitworth and Mr. Hulse relative to the Drawings supplied to Mr. Anderson for this Gun, and contending for the origination of the Gun by Mr. Whitworth:*

Written statement and examination in detail relative to the drawings supplied by witness to Mr. Anderson for the construction of his 7-inch gun at Woolwich, and the alterations made therein by Mr. Anderson in order to adopt the construction to the mode of manufacture at the Gun Factory; denial that the altered drawings involved any essential difference, *Whitworth* 1099–1102. 1125 *et seq.*——Consultation between witness's partner and Mr. Anderson with reference to the modifications first proposed by the latter in witness's original drawing, *ib.* 1102.

Material difference between the 7-inch gun designed by witness and the Armstrong 7-inch gun; much greater weight of the former, *Whitworth* 1102. 1129——The weight of the gun is a little over seven tons, whilst the weight of the service gun is only four tons, *ib.* 1102. 1184——Reference to several letters from Mr. Anderson as mentioning the slight character of the alterations proposed by him, and ultimately consented to by witness, *ib.* 1102.

Further evidence to the effect that the mode of manufacture at Woolwich being different from witness's mode, he left it to Mr. Anderson to carry out the details of his gun, but that the deviations from the original drawings are not material, *Whitworth* 1131 *et seq.*——Concurrence of Mr. Anderson in the written statement prepared by witness, *ib.* 1132——Witness would have preferred an implicit adherence to the original drawings, *ib.* 1144. 1156.

Valuable assistance was doubtless derived by witness from Mr. Anderson in the manufacture of the 7-inch gun, *Whitworth* 1447–1450——Explanation as to witness having been obliged to have recourse to the Royal Gun Factory for the manufacture of his 7-inch gun on account of the machinery there available, *ib.* 1452–1460.

Explanatory statement relative to witness's communication with Mr. Anderson on the subject of the drawings for the Whitworth 7-inch gun, and examination as to the points of difference between this gun and the Armstrong 7-inch gun, *Hulse* 1469 *et seq.*——With regard to the outside coil or hoop of the Whitworth gun, it was first suggested by witness, and not by Mr. Anderson, *ib.* 1504–1515.

Examination with reference to the two papers read over to Mr. Anderson, purporting to give an account of the proceedings in connexion with the 7-inch gun; conclusion as to Mr. Anderson having partially concurred as to the entire accuracy of these statements, *Whitworth, Hulse and Aston* 1685, 1689–1739——Witness hands in the original statement read by him to Mr. Anderson as to the facts in connexion with the 7-inch gun, *Hulse* 1903——Also gives further explanation as to what passed at his personal communication with Mr. Anderson on the subject of the drawings, *ib.* 1905.

2. *Evidence of Mr. Anderson, explanatory of the Alterations made in the Original Drawings, and contending that the Gun was eventually constructed upon the Armstrong Principle:*

Consideration of the question as to witness having concurred in certain written statements submitted to him by Mr. Whitworth and Mr. Hulse, explanatory of their case in the matter of the 7-inch gun made for Mr. Whitworth at Woolwich; explanation, that in giving his assent to the general accuracy of these papers witness took exception to one or two passages in the statement read to him by Mr. Hulse, *Anderson* 1672–1681. 1683, 1684. 1686–1688. 1690, 1691——Witness lays before the Committee a written statement of the transactions connected with the manufacture of the gun for Mr. Whitworth, showing also the objections to the drawings first submitted by Mr. Whitworth, and

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SEVEN-INCH WHITWORTH GUNS—continued.

2. *Evidence of Mr. Anderson, &c.*—continued.

and the differences between the gun as first intended by him and as eventually manufactured, *Anderson* 1682——Conclusion arrived at, that the gun first submitted by Mr. Whitworth was wrong, both in principle and in detail; several objections to this gun, *ib.* 1862. 1756–1765.

Statement as to the exterior hoop of the gun having been originated by witness, rather than by Mr. Hulse, *Anderson* 1682. 1776, 1777——In the construction of the Whitworth gun, the whole experience gained by the Royal Gun Factory in the manufacture of the Armstrong gun was made available, *ib.* 1682——Sanction given on the part of Mr. Whitworth to the several alterations made by witness in the original drawings, *ib.* 1740–1749——Opinion that Mr. Whitworth is not justified in speaking of the gun altered by witness, as his gun, *ib.* 1750–1765. 1817–1830.

Respects in which the gun made for Mr. Whitworth differs from the Armstrong gun, further adverted to; conclusion that it is nevertheless made on the same principle of construction as the Armstrong gun, *Anderson* 1766 *et seq.*——Sir W. Armstrong had nothing to do with the drawings for the Whitworth 7-inch gun, *ib.* 1837, 1838. 1901–1903.

Further consideration of the points of difference between the 7-inch gun, as designed by Mr. Whitworth, and as altered and constructed by witness; conclusion further arrived at, that this gun was made on the Armstrong principle, *Anderson* 1854 *et seq.*——Explanation, that witness admits the accuracy generally of the statements of facts read over to him by Mr. Whitworth and Mr. Hulse, but that he disputes the inferences attempted to be drawn by those gentlemen from the facts, *ib.* 1954–1962——The statements of Mr. Whitworth and Mr. Hulse were different, but the facts were substantially the same, *ib.* 1955, 1956.

3. *Papers and Correspondence in further elucidation of the Proceedings connected with this Gun:*

Copy of correspondence in 1861–62 between Messrs. Whitworth & Co. and Mr. Anderson on the subject of the tracings for the 7-inch gun of Mr. Whitworth, to be made in the Gun Factories, *App.* 298, 299——Communication from Sir W. Armstrong to the Under Secretary of State for War, dated 17 November 1862, requesting an inquiry into the statements by Mr. Whitworth, in a letter to the "Times," relative to the construction of the 7-inch gun at Woolwich, *ib.* 298.

Papers relative to Mr. Whitworth's assertions in letters to the "Times," dated 11 October and 8 November 1862, in regard to the construction of the 7-inch gun, *App.* 305–308——Report by the Ordnance Select Committee, dated 1 December 1862, in which exceptions are taken to certain statements made by Mr. Whitworth in letters to the "Times," *ib.* 305, 306.

Extract from the "London Review" of 15 November 1862, in which Mr. Whitworth's claims in regard to the origination by him of his 7-inch gun, &c. are disputed, *App.* 307, 308.

Correspondence in 1861 and 1862 relative to Mr. Whitworth's 7-inch gun, comprising letters from Mr. Anderson, from Mr. Whitworth and the Whitworth Ordnance Company, and from Mr. Hulse, with reference more especially to the drawings for the 7-inch gun made in the Gun Factory, *App.* 404–407.

Statements, dated 29 April 1863, by Mr. Baker and Mr. Sandeman, respectively principal clerk and chief draughtsman in the Royal Gun Factories, relative to the circumstances connected with the drawings for the 7-inch gun, *App.* 459.

Paper submitted to the Committee by Mr. Hulse, being a memorandum for statement as to 7-inch gun drawings, and in support of the proposition that, "the gun was made according to drawings supplied by Mr. Whitworth," *App.* 460, 461.

4. *Damaged State of the Gun:*

The 7-inch gun made at Woolwich on the Armstrong principle is not capable of firing many rounds although it has not been fired very often, *Sir W. Wiseman* 208–215——The gun is damaged probably by the explosion of the powder and the friction of the shot, *ib.* 216, 217——The gun is now defective in the bore or inner tube, though it has not fired many rounds; cause of this failure considered, *Anderson* 1839, 1840. 1904–1912. 1921–1936.

Seventy-Pounder Armstrong Guns. Value attached by witness in the first instance to a 70-pounder Armstrong gun as capable of firing a 100 lb. shot; the advantage of this has not been confirmed by experience, *Duke of Somerset* 5108. 5129.

Reports by the Ordnance Select Committee in 1862 relative to the Armstrong 70-pounder gun, with new side breech-loading arrangement, *App.* 342–345.

Total number of 70-pounder guns supplied by the Elswick Company up to 31 March 1863, including those outstanding, *App.* 379.

Total number of 70-pounders made in the Royal Gun Factory; distinguishing between the number made and issued for service and the number made but not yet issued, *App.* 380.

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Seymour, Captain F. Beauchamp, R. N., C. B. (Analysis of his Evidence.)—Was in command of the Australian station up to July 1862, there having been two 12-pounder Armstrong guns in the squadron, 2296, 2297——Saw three Armstrong guns of Captain Mercer's battery in action in New Zealand in March 1861, 2297, 2298——Considers that the Armstrong gun or any other breech-loading is decidedly unsuitable for the navy, 2299. 2322——Circumstance of breech-loaders being altogether discountenanced in the American navy, 2299. 2323——Injurious results of practice with an Armstrong 12-pounder on board the "Harrier," 2299. 2303. 2317-2319.

Accuracy of the Armstrong gun when fired on shore at distances above 1,500 yards, 2299. 2321——Opinion as to the greater accuracy at sea for distances under 1,500 yards, of the 68-pounder gun, 2299, 2300. 2320—— Serious defect of the Armstrong ammunition on account of the stripping of the lead coating, 2300——Statement as to the want of accuracy of three Armstrong guns used by the Royal Artillery in action in New Zealand; favourable opinion entertained of these guns by Captain Mercer of the artillery, 2301-2304. 2308-2316. 2339-2349.

Expediency of testing the Armstrong heavy guns by firing quickly 20 or 25 rounds with the service charge, and six or eight degrees of elevation, 2305——Small proportion of rifled guns in American ships; approval thereof, 2323, 2324——Extensive adoption in the French navy of the old 32-pounder gun rifled; advantages of this gun, 2325-2331——Approval of an exclusive use of muzzle-loaders, 2331.

"Shannon," H. M. S. Some firing with the Armstrong guns on board the "Shannon" was about the worst that witness ever saw, *Wainwright* 3771.

Shells. See *Projectiles or Shells.*

Shoeburyness. See *Experiments.*

Shorncliffe. See *Experiments.*

Shot. See *Projectiles or Shells.*

Shrapnell Shells. See *Projectiles or Shells.*

Shunt Gun. See *Muzzle-loaders*, 2.

Sights (*Armstrong Guns*). The sights of the Armstrong gun are too complicated for general use, and are altogether too fine, *Jerningham* 3626. 3633. 3637——Doubt as to the accuracy of a calculation that the sighting, &c. of 1,562 Armstrong guns at Woolwich cost 40 *l.* a gun, *Baring* 5341, 5342——Examination on the subject of an item of 62,950 *l.* charged for sighting and browning Armstrong guns; other expenditure besides sighting and browning included in this charge, *Anderson* 5438-5480——Reference to a certain discrepancy between the return furnished in July 1862 and the return furnished this year, as for the sighting, &c. of guns; explanation thereupon, *Whiffin* 5612-5615.

Statement explanatory of the results as regards the trunnion-sights and the tangent-sights of the Armstrong guns with which experiments were made on board the "Cambridge," &c., *App.* 321.

Six-hundred Pounder Armstrong Gun. The largest gun now completed on witness's principle is a 600-pounder rifled muzzle-loader of 13½ inch bore, *Sir W. G. Armstrong* 3227.

Six-Pounder Armstrong Guns. Total number of 6-pounders made in the Royal Gun Factory, distinguishing between the number made and issued for service and the number made but not yet issued, *App.* 380——Total of 37 6-pounder Armstrong guns issued up to February 1863, all of which were made at the Royal Gun Factory, *ib.* 530.

Sixty-eight Pounder Smooth-bore Gun. See *Iron-plated Ships. Navy, The. Smooth-bore Guns.*

Small Arms. Considerable sacrifices incurred in connexion with the introduction of rifled small arms, *Sir W. G. Armstrong* 3228.

Abstract of correspondence between Mr. Whitworth and War Office, from 1854 to 1860, on the subject connected with small arms and large ordnance; together with a detail of portion of the expenses on account of these experiments referred to in Return, at page 283 of the Report of the Committee on Ordnance, dated July 1862, amounting to 11,292 *l.* 17 *s.* 1 *d.*, *App.* 382-393.

Smoke (*Armstrong Guns*). Character of the powder adverted to with reference to the thick smoke caused on board ship, *Cochrane* 2236-2240——2254-2258. 2290; *Duke of Somerset* 5212-5215——Great inconvenience on board the "Black Lion" on account of the thickness of the smoke from the Armstrong gun, *Wainwright* 3779——Thickness of the smoke adverted to, *Ewart* 4553.

Smooth-bore Guns:

Advantage in a certain proportion of smooth-bores being retained in the service; their efficacy at short ranges, *Gardner* 26-29. 37-47——Opinion as to the decided inferiority of the smooth-bore gun, *Sir W. Wiseman* 196, 197——Certain purposes, such as rapid movements of horse artillery, for which the old smooth-bore gun should still be retained as preferable to the rifled gun, *Bingham* 376. 529-532.

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Smooth-Bore Guns—continued.

Advantage of smooth-bore muzzle-loaders over rifled breech-loaders for close fighting at sea, especially against iron ships, *Coles* 1576. 1583-1585. 1611-1613. 1619, 1620. 1633-1640; *Cochrane* 2237——Approval of the present limit to the proportion of Armstrong guns on board men-of-war, on account of the many advantages possessed in other ways by smooth-bore guns, *Coles* 1585-1587. 1637-1640; *Cochrane* 2262-2277; *Admiral Dacres* 3174, 3175. 3198-3215; *Hewlett* 3273-3275; *Ewart* 4554, 4555. 4569, 4570——Immense practice in the Crimea with the 68-pounder and other smooth-bore guns, and very favourable result thereof, *Sir R. Dacres* 2174-2180——Somewhat less rapidity and precision of firing with the 68-pounder than the 110-pounder, *Cochrane* 2245-2247.

Illustrations during the late Italian campaign, as well as at Shoeburyness, of the inferiority of the smooth-bore to the rifled gun, *Sir W. Armstrong* 3165, 3166——Witness has no doubt but the days of smooth-bore guns are approaching to a close, *ib.* 3165——Witness feels perfectly satisfied that whenever smooth-bore ordnance is brought into conflict with rifled ordnance, whether in the field, or at sea, or in siege operations, the former will invariably succumb, *ib.* 3167.

Inferiority of the rifled breech-loader, as compared with the smooth-bore, for the penetration of iron plates, on account of the less initial velocity of the rifled gun, *Jerningham* 3646, 3647. 3694-3700——It would, however, be useless to employ the 68-pounder against iron plates at a greater distance than 200 yards, *ib.* 3695——Superior advantages of the rifled gun over the smooth-bore gun, if it could fire with accuracy and range, not only elongated but spherical projectiles, and if a great initial velocity could be secured, *ib.* 3714-3719——In general action, in rough weather, witness would however prefer, on the whole, the smooth-bore gun, *ib.* 3744.

Much too complicated character of the rifled breech-loading gun, as compared with the smooth-bore gun, for use in close action; very prejudicial effect of any accidents under such circumstances, *Wainwright* 3783. 3794-3797——Witness prefers the old smooth-bore to the rifled gun, in general action as well as against forts and rifled plates, *ib.* 3802-3810.

Circumstance of an experiment in the autumn of 1860 having shown that the Armstrong 80-pounder was inferior to the 68-pounder smooth gun against iron plates, *Scott* 4116. 4122-4125——Inferiority at the present time, of the Armstrong naval gun, as compared with the smooth-bore against plated ships, *ib.* 4124-4128——Less accuracy of the Armstrong naval gun than of the smooth-bore; concurrence in the opinion hereon of Captain Wainwright, *ib.* 4139, 4140. 4147-4152——Defect of the Armstrong gun on the score of initial velocity, as compared with the smooth-bore gun, *ib.* 4153-4161——Circumstance of the Horsfall smooth-bore gun having pierced iron plates at a distance of 800 yards; great weight of this gun, *ib.* 4163-4167.

Preference for the smooth-bore gun over the rifled breech-loader or muzzle-loader for quick firing at close quarters, that is, on account of the complicated character of the latter, *Ewart* 4549. 4564-4568. 4570-4583——The 68-pounder smooth-bore is the best gun at close quarters, and future actions are likely to be settled at close distances, *ib.* 4573-4576. 4579-4583——Witness considers the 68-pounder smooth-bore quite ineffective against iron-plated ships, *Blakely* 4821, 4822.

Result now arrived at, that for naval purposes at 200 yards the old 68-pounder is a more powerful gun than the Armstrong 100-pounder, *Duke of Somerset* 5102. 5108. 5121-5123——Opinion that a much more powerful gun than the 68-pounder is now required, *ib.* 5103——Recent correction of the error that smooth-bore guns possessed a greater velocity than rifled guns, *ib.* 5138. 5216, 5217.

Conclusion as to the greater advantage of the old 98-pounder than of the Armstrong 100-pounder at close quarters, and against iron-plated ships, *Rep.* vii.

See also *Accuracy. Armstrong Guns. Cast-iron Guns. France. Initial Velocity. Iron-plated Ships. Martello Towers. Navy, The. Range of Guns. Ricochet Firing.*

Solid Forgings. Intention in witness's original drawing to have a solid forged breech-piece for his 7-inch gun, *Whitworth* 1200-1203.

Conclusion that it is entirely out of the question to make large guns on the principle of solid forged tubes, either of steel or iron, *Sir W. G. Armstrong* 3163——Much less satisfactory character of internal barrels made from solid forgings of wrought iron, than of coiled barrels, *ib.*

Somerset, His Grace the Duke of, K.G. (Analysis of his Evidence.)—Has been First Lord of the Admiralty since July 1859; 5093——Responsibility of the Admiralty for the guns introduced into the Navy, it being necessary, however, to obtain all supplies from the War Department, 5094, 5095. 5142——Difficulty in regard to the introduction into the Navy of any gun not sanctioned by the War Department, no gun having ever been adopted which had not been passed by the Ordnance Select Committee, 509-5096. 5142-5153——Circumstance of one of the Members of the Ordnance Select Committee

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Somerset, His Grace the Duke of, K.G. (Analysis of his Evidence)—*continued.*

being a naval officer, appointed by the Admiralty, 5097, 5098. 5144-5147——There is also a naval officer in the War Department who conducts all the correspondence with the Admiralty relative to requisitions for guns, 5099. 5148-5150.

Statement showing that when witness entered upon his present office, in July 1859, he had before him reports condemnatory of almost all the guns then known, except the Armstrong gun, which was reported upon most favourably, 5100——Application by the Admiralty to the War Department, in July 1859, for some 40-pounder Armstrongs, *ib.* —— Frequent communication between witness and the late Lord Herbert, in 1859 and 1860, relative to the adoption of an Armstrong 70-pounder or 100-pounder for naval purposes, 5100. 5102.

Reference to the abandonment of attempts to rifle cast-iron guns; approval thereof, 5100, 5101. 5195——Difficulty in obtaining a satisfactory muzzle-loading gun, so that witness in applying for the Armstrong gun was so far obliged to adopt the breech-loading principle, 5100, 5101. 5195-5203——Opinion that the Armstrong 100-pounder, although possessing some great advantages, has not proved entirely satisfactory for the naval service, 5102——Doubt expressed by witness in 1860 as to the 100-pounders being found effective for broadside purpose; subsequent experience has tended to confirm this opinion, 5102. 5118-5123.

Result now arrived at, that for naval purposes at 200 yards, the old 68-pounder is a more powerful gun than the Armstrong 100-pounder, 5102. 5108. 5121-5123——Opinion that a much more powerful gun than the 68-pounder is now required, 5103 ——Witness would like a gun, either smooth-bored or rifled, which could fire about 25 lbs. of powder and a projectile of about 150 lbs., *ib.*——Application made by witness to Mr. Whitworth, in November 1860, relative to the construction of a rifled gun, which could be used also with spherical shot; reply by Mr. Whitworth that this was not practicable, 5104.

With regard to Captain Blakely's gun, witness had no such experience of it as would justify him in requesting the War Department to provide it, 5105——Requisition made by the Admiralty in February 1861 for 200 Armstrong 110-pounders; data by which they were guided in making so large a demand, 5106-5108. 5110-5114——Value attached by witness in the first instance to a 70-pounder Armstrong gun as capable of firing a 100-lb. shot; the advantage of this has not been confirmed by experience, 5108. 5129——Insufficient experience in 1861 on the subject of initial and terminal velocities; uncertainty on this question even at the present time, 5108. 5134. 5216, 5217.

Further statement that at present there is no better gun than the 68-pounder at close quarters, 5108, 5109——Considerable investigations and experiments still necessary in order to arrive at the best gun for the Navy, 5109. 5216-5218——Opinion as to the ineffective character of the French naval gun, on account of the small charge of powder used with it, 5110. 5117——Information relative to the several requisitions made from time to time by the Admiralty for Armstrong guns; the last requisition was in November 1862, for two 110-pounders on the shunt principle, 5110-5115.

Statement as to the Admiralty having, in October 1862, declined any more 110-pounder Armstrongs, 5114——Desire expressed by the Admiralty in October last, for twenty 150-pounder smooth-bore guns; some of these are now being provided, 5114. 5129—— Explanation relative to the requisition for two wrought-iron shunt guns; doubt whether these have been finally passed by the Ordnance Select Committee, 5115, 5116.

Reports of officers in command of ships adverted to as not approving generally of the Armstrong gun between decks, but as favourable to it upon the upper deck as a pivot gun or chase gun, 5118-5121——Suggestions made by naval officers for improvements in the gun, as in the sighting, &c., 5124——Considerable approval expressed by naval officers in the case of the Armstrong 40-pounder, 5126-5128.

Objection to an elongated projectile in so far as being a means of putting an undue weight of shot into the gun, requiring an unduly large charge of powder, 5129, 5130—— Tendency to injure the gun by putting in double charges of powder in testing, 5130—— Weakness of the vent-piece adverted to as a great objection to the Armstrong gun, 5131. 5139——Reference to the Armstrong segment shell as a beautiful invention, 5131.

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With regard to the report of the Ordnance Select Committee, in which, at first, the Armstrong gun was strongly recommended for adoption, this referred only to the gun as a field gun, 5158-5162——The only Armstrong gun for the navy included in the War Office Estimates for 1859-60, was a 70-pounder Armstrong gun, 5163-5167——Although the Admiralty are responsible for the natures of the guns ordered, they could not act altogether independently of the War Office, 5168-5171. 5195——The Armstrong guns had been tried in the Navy, and thought very highly of before the Admiralty made the requisitions of July 1859 and February 1861; 5172-5180.

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Sponges (Armstrong Gun). Result of an experiment in October 1861, in order to ascertain whether the sponge with the flat solid head, would answer the purpose of a rammer, as well as that of a sponge, *App.* 445——Report on bristle sponges for the 100-pounder guns, after such sponges had been in use for several months on board the "Excellent"; satisfactory results obtained, *ib.* 446, 447——Details of an experiment in order to ascertain whether, when using Colonel Boxer's lubricators with the Armstrong guns, the application of the sponge would be necessary during the practice; satisfactory results obtained, *ib.* 449, 450.

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Steel, or Homogeneous Metal:

1. *Use by Mr. Whitworth of Mild Steel or Homogeneous Iron: his views as to its Advantages.*
2. *Explanation as to Sir W. Armstrong having from the first contemplated the use of Steel for the Inner Barrel.*
3. *Contemplated use of Steel by Captain Blakely in* 1855.
4. *Merits of the Steel Guns made by Krupp, of Essen.*
5. *Merits of Mr. Naylor Vickers' Gun.*
6. *Evidence in Approval generally of Homogeneous Metal or Steel, if the proper quality can be secured.*

1. *Use by Mr. Whitworth of Mild Steel or Homogeneous Iron; his views as to its Advantages:*

Witness considers the use of mild steel or homogeneous iron for the inner tube, a distinctive feature of his gun, *Whitworth* 1317——Manufacture of several of witness's guns with homogeneous metal; this manufacture is now going on, *ib.* 1461–1466——Circumstance of Mr. Whitworth having been desirous that homogeneous metal should be used for his 7-inch gun made at the Gun Factory, *Anderson* 1949–1953.

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Further reference to the use by witness of homogeneous metal for the inner tube, as far superior to welded metal or wrought iron, *Whitworth* 2487. 2616, 2617——Statement as to witness having first proposed in 1859 to use homogeneous iron, and having in 1861 made applications to Woolwich, with a view to trying his principle of rifling with large guns made on the coil system, *ib.* 2561–2570. 2593-2595——Excellent results obtained from the use of homogeneous metal for the smaller guns, *ib.* 2565——Witness always had reason to be satisfied with the strength of homogeneous iron, *ib.* 2565. 2593——About equal expense of guns of homogeneous metal and of brass, *ib.* 2614.

Metal now produced by witness's firm of such quality, that if the projectile were placed at a certain distance from the powder, the gun would bulge rather than burst, *Whitworth* 2974. 2977. 3000——Much greater strength of the homogeneous metal advocated by witness than of welded metal, *ib.* 2974——Equal perfection recently attained in the manipulation of homogeneous metal for large guns, as had been previously secured in the case of small guns, *ib.* 2974–2977——Harder and stronger homogeneous metal used for the hoops than for the tube, *ib.* 2977——Less liability to flaws where homogeneous metal is used, *ib.* 2996–2999——Improved process now adopted in the manufacture and manipulation of the homogeneous metal, *ib.* 3013–3017.

2. *Explanation as to Sir W. Armstrong having from the first contemplated the use of Steel for the Inner Barrel:*

Favourable opinion entertained from the first by Sir W. Armstrong, as to the merits of steel for the interior tube, if its brittleness could be got over, *Anderson* 1843–1849——Use of homogeneous metal in the barrel of the first gun made by Sir W. Armstrong, *Noble* 3149.

Former report by witness adverted to, as showing that the fundamental idea of his system was to form a gun upon the principle of a fowling-piece, and involved the use of twisted cylinders of wrought iron, shrunk upon a steel centre or barrel, *Sir W. G. Armstrong* 3163——Opinion expressed from the first by witness, and now reiterated, that steel is the proper metal for the barrel of a gun, if it can only be obtained of uniform and proper quality, *ib.*——The steel barrel was in fact one of the chief peculiar features of the gun first made by witness for Government, *ib.*——Concurrence between Mr. Whitworth and witness as to the expediency of using steel tubes, if the proper quality of metal can be procured, *ib.*

Witness's first gun was made with a steel tube, and he would still prefer steel for the inner tube, if a uniform quality of metal can be secured, *Sir W. G. Armstrong* 3507-3511. 3855–3861——With regard to Captain Blakely's plan of hooping, in conjunction with the use of steel barrels, witness would always have used steel, if he could have obtained it, *ib.* 5002–5009.

3. *Contemplated Use of Steel by Captain Blakely in* 1855*:*

Reference to witness's specification as showing that it included the use of a steel barrel with wrought-iron coils, *Blakely* 4631. 4638–4642——With regard to the use of steel, if Sir W. Armstrong now makes the gun with a steel barrel enclosed in a casing of coils, he makes precisely the gun offered by witness to the Government in 1855, minus the rifling, *ib.* 4650–4656——Witness was fully aware that a steel casing would be better than coils if steel could be obtained of the proper character, *ib.* 4659.

4. *Merits*

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4. *Merits of the Steel Guns made by Krupp of Essen:*

Severe test to which the Krupp gun has been subjected without injury, *Gardner* 71—— Disapproval of the use of the same amount of steel as in Krupp's guns, *Anderson* 668–671 ——Great value attached to the system of manufacture of Krupp of Essen, *Whitworth* 1454——Excellent character of the 100-pounder at Woolwich made by Krupp, *Anderson* 1938–1942.

Reference to the recent bursting of one of Krupp's steel guns at Woolwich, *Tulloh* 2728, 2729. 3734–2746——The trials made with Krupp's guns, as well as the difficulty of securing steel uniformly good, did not justify the manufacture of guns upon Krupp's principle, *Sir W. G. Armstrong* 3944–3948.

Very severe test stood by the Krupp 100-pounder steel gun, *Scott* 4439, 4447——Statement as to Krupp's guns being made from steel cast and hammered, *ib.* 4450. 4458–4460 ——Failure of some small steel guns of Krupp tried in 1851, *ib.* 4461, 4462.

5. *Merits of Mr. Naylor Vickers' Gun:*

Very severe test withstood by the 40-pounder gun of Mr. Naylor Vickers, made from a solid mass of cast steel; cost of this gun, *Scott* 4439–4449.

6. *Evidence in approval generally of Homogeneous Metal or Steel, if the proper quality can be secured:*

Preference now given by witness to homogeneous metal or steel as compared with wrought-iron as the material for the inner tube; difficulty, however, on account of the uncertainty and the expense, *Anderson* 661–671. 1841–1842. 1849–1853. 1915–1920. 1943–1948——Advantage in making the 6-pounder and 12-pounder of one piece if steel could be depended upon, *ib.* 1851——Opinion that the best gun would be one with a steel lining, strengthened with wrought-iron coils, *Tulloh* 2724–2733——Advantage of homogeneous metal being now extensively used, but only for the barrel or centre of the gun, *Noble* 3149–3152.

Imprudence of any large use of mild steel or homogeneous iron until it can be produced of a sufficiently uniform quality, *Sir W. G. Armstrong* 3163——If steel of a proper and uniform quality could be procured, witness would prefer it for the barrel, but this desideratum has not yet been arrived at, *ib.* 3163. 3507–3511. 3855–3861——Mr. Whitworth's proposal for an interior of steel, with external hoops of steel screwed together, has never been submitted to the authorities, *ib.* 3227——Unsatisfactory experience in the case of homogeneous metal, as hitherto used by Mr. Whitworth, 3228——Grounds for concluding that the process of annealing, as applied to steel, tends to deteriorate the quality of the metal, *ib.* 3858–3861——Crystalline wrought-iron, as produced by the annealing of steel, is about the very worst material for the barrel, *ib.* 3861.

Decided preference for mild steel or homogeneous iron as the material for the inner tube, *Scott* 4396–4398——Greater danger when a steel gun bursts than when a wrought-iron gun gives way, *ib.* 4451–4454——Want of proper inducement for the supply of the peculiar kind of steel desirable, or it would have been provided some years ago, *ib.* 4463–4469——It is now found that the proper quality of steel can be procured, and Mr. Whitworth is adopting this material, as preferable to coiled wrought-iron, *ib.* 4470–4472.

The whole of a moderately-sized gun should be made of steel, *Blakely* 4607. 4640—— Advantage of the cast steel guns made by witness since 1859, as not involving the defect of a weld outside for the hoops, *ib.* 4626——Preference of witness for steel tubes as compared with coiled iron tubes, *ib.* 4638——Opinion that steel exclusively should be used for guns not of large size, *ib.* 4640——Advantage of making hoops or cylinders out of cast steel, hammered and annealed, *ib.* 4685——Upon the whole, witness advises the condemnation of the 68-pounders and 32-pounders and of the Armstrong 100-pounders and the introduction of guns made of steel throughout, *ib.* 4719–4723.

Difficulty in obtaining the homogeneous metal contemplated by Mr. Whitworth, so that his system has not been properly tested, *Duke of Somerset* 5185. 5188. 5195–5204.

With regard to the use of wrought-iron or of steel for the outer tube of the gun, witness repeats that he would prefer the latter if the proper quality could be obtained, as it probably soon shall be, *Anderson* 5548. 5549——With his present experience, witness would trust more to wrought-iron than to steel for the outer tube, 5548.

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Submarine Gun. Results of experiments in June and July 1862, with the 110-pounder Armstrong gun, as a submarine gun, *App.* 451, 452——Further experiments in September 1862, with a view to ascertaining the penetration &c. of the 110-pounder gun, when fired under water, *ib.* 452, 453——Further experiments in October 1862, in order to ascertain the effect of Armstrong guns, when fired under water, *ib.* 456——Continuation of the experiments for ascertaining the penetration, &c. of guns fired under water; results arrived at, *ib.* 456, 457.

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Ten-inch Shells. See *Projectiles or Shells*, 7.

Three-hundred Pounders. Failure at the breech of a 300-pounder smooth-bore gun at Shoeburyness, *Scott* 4362. 4454–4457.

Total number of 300-pounder guns supplied by the Elswick Company up to 31st March 1863, including those outstanding, *App.* 379——Total number of 300-pounders made in the Royal Gun Factory, distinguishing between the number made and issued for service, and the number made but not yet issued, *ib.* 380.

Details as to the results obtained from trials at Shoeburyness with Armstrong 300-pounders against iron plates, *App.* 521-523.

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Trials of Guns. See *Experiments.*

Tulloh, Major General Alexander Thomas. (Analysis of his Evidence.)—Ceased to be Inspector of Artillery on the 8th July 1861; whilst holding that office, examined 169 12-pounder Armstrong guns, 2618, 2619——None of the guns referred to in the Report of the Committee of 17th November 1862 as having failed, were inspected by witness; these underwent the usual proof, 2620–2622. 2705–2718——Since the final proof was discontinued, that is subsequently to Lord Herbert's order, the Inspector of Artillery has selected the guns and made records of those received into the service, but has no responsibility whatever in regard to the construction of the guns made in the Royal Factory, 2620 *et seq.*

Two lined guns were passed by witness, but he had no idea that they had been lined, 2622. 2649–2656——Responsibility of the Superintendent of the Gun Factory for the proving and examination of the guns made therein, 2629. 2646——Appointment in the first instance of an officer to inspect the manufacture at Elswick, in addition to the inspection at Woolwich by the Inspector of Artillery, 2657–2659——Of nineteen guns rejected by witness when Inspector of Artillery none were subsequently passed by him, but they have since been dealt with and passed by the Superintendent of the Gun Factory, 2661, 2662. 2668–2671.

Further statement as to witness not having proved the Armstrong guns, nor having been responsible for them, 2662–2674——The issue of lined guns to the service has been discontinued, 2671, 2672——Guns returned to the arsenal on account of flaws will be made serviceable and again sent out, 2673, 2674——Unduly severe test to which the Armstrong guns were at first subjected; the proof is now reduced, 2674–2677——The guns have been greatly improved since the commencement, 2680.

Very few Armstrong guns now being made, 2681, 2682——Some 40-pounders recently made have stood the proof very well, 2683–2685——As a field gun the Armstrong gun is superior to any yet in the service, 2686, 2687——Considerable improvement recently made in the vent-pieces in the case of the 40-pounder guns, that is, by the use of Swedish iron; equal improvement expected as regards the 12-pounders, 2688–2699. 2816–2822——The weight of the 12-pounder is eight cwt., that of the old 9-pounder having been thirteen cwt.; approval of the former weight, 2694. 2827–2830.

Erroneous character of a certain form stating that the guns were tested by the Inspector of Artillery, 2700–2704——The flaws or defects in the guns have not been generally of a serious kind, 2719–2723——Opinion that the best gun would be one with a steel lining strengthened with wrought-iron coils, 2724–2733——Reference to the recent bursting of one of Krupp's steel guns at Woolwich, 2728, 2729. 2734–2746——Limited information which witness is in a position to give with reference to Krupp's guns, or the question as to the use of steel or homogeneous metal; his functions as Director of Ordnance adverted to hereon, 2725–2778. 2848–2855.

Further statement opposed to the use of very heavy charges in proving guns; severe proof in the case of the Whitworth guns tried at Shorncliffe adverted to hereon, 2779–2796——Return of wrought-iron guns burst at proof, 2797——Doubt as to the expediency of marking guns so as to explain the number of flaws, whether lined, &c.; sufficiency of the written history of the gun furnished to the officer in charge, 2798–2815——Preference on the whole for muzzle-loading guns if they can secure the same range and accuracy as breech-loaders, 2823–2826.

Use to be made of the fuzes referred to by Captain Gordon as having cost 45,000 *l.*; it is not the fact that they are unserviceable, but only that unproved ones are to be introduced, 2831–2847——These fuzes will be used for practice, instead of for active service, 2831–2842——Duty of Mr. M'Kinlay, the proof master at the Gun Factory, merely to see that the proof was carried on safely, 2856, 2857.

Opinion as to the advantage of an Artillery officer at the head of the Gun Factory who should exercise an independent inspection, 2858 *et seq.*——Respects in which advantage would result from an independent check upon the manufacture, although during

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Tulloh, Major-General Alexander Thomas. (Analysis of his Evidence)—*continued.*

during the Russian war no evil was attributable to the present system of heads of departments without a superintending chief, 2861 *et seq.*—— Advantage in the independent inspection being continuous during manufacture, 2902–2927.

Independent inspection of the guns made at Elswick, 2951–2954——More numerous objections in the case of guns made at Woolwich than at Elswick, the number of guns made being much greater at Woolwich; system of inspection at each place adverted to hereon, 2958–2965——Reference to the number of Elswick guns issued for service, 2966——Probability of an equally rigid inspection of contract articles by the heads of departments at Woolwich as of articles made by themselves, 2967–2972.

Twelve-pounder Guns. See *Experiments. Failures and Defects. Field Guns. Lined Guns* (*12-pounders.*) *Vent-pieces.*

Twenty-pounder Armstrong Guns. Only one 20-pounder has been returned for repair, and that is a lined gun, *Sir W. G. Armstrong,* 3869.

Return from Her Majesty's ship "Cambridge" of the experimental firing from on board that ship, &c., with the Armstrong 20-pounders, showing the results of the practice, and the different defects or accidents produced in the guns, *App.* 316, 317.

Total of thirty 20-pounder guns supplied by the Elswick Company up to 31st March 1863, including those ourstanding, *App.* 379——Total of 319 20-pounders made in the Royal Gun Factory, distinguishing between those made and issued for service, and the number made but not yet issued, *ib.* 380.

Total number of Armstrong 20-pounders issued up to February 1863, and number made respectively at Elswick and at Woolwich, *App.* 530.

Twenty-four Pounder Whitworth Guns. Return from Her Majesty's ship "Excellent" in December 1857, containing details of trials with Mr. Whitworth's 24-pounder brass-rifled howitzer, *App.* 408–415.

Twenty-five Pounder Armstrong Guns. Impression that two 25-pounder Armstrong guns made at Elswick and found faulty were subsequently lined there, *Noble* 3153–3155.

Statement showing the amount and rates paid for 25-pounder guns to the Elswick Ordnance Company, compared with the original rates assumed in Sir W. G. Armstrong's letters, numbers 4 and 5, printed in the Appendix to the Report from the Select Committee on Ordnance in 1862 (p. 252), *App.* 466——Great difference between the actual rates paid and the rates assumed in the letters from Sir W. Armstrong in 1858, the former being only about half the amount of the latter, *ib.* 467.

Statement showing the cost of 25-pounder guns, as obtained from the Elswick Ordnance Company, compared with the rates of those produced at the Royal Arsenal, Woolwich, *App.* 480.

U.

Unloading of Rifled Guns. Difficulty in regard to drawing the charge of rifled guns, when going into harbour; suggestion hereon, *Jerningham* 3641. 3648.

V.

Vent-pieces (Armstrong Guns):

1. *Generally as to the Failures of Vent-pieces at Shoeburyness and Porsmouth, and in the Navy.*
2. *Explanation by Sir W. Armstrong as to the comparatively small number of failures in proportion to the Practice.*
3. *Difficulty more especially in the case of the larger guns.*
4. *Prevention of accident if proper care be taken.*
5. *Improvements effected from time to time, and further improvement anticipated.*
6. *Statement of the changes in the pattern, and of the authority for such changes.*

1. *Generally as to the Failures of Vent-pieces at Shoeburyness and Portsmouth, and in the Navy:*

Great defect of the Armstrong breech-loader on account of the liability of the vent-piece to break; several instances of this at Shoeburyness, *Gardner* 8–21. 24. 72. 104——During the last two years, between sixty and seventy vent-pieces have broken at Shoeburyness, *ib.* 10–13. 15.

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VENT-PIECES (*ARMSTRONG GUNS*)—continued.

1. *Generally as to the Failures of Vent-pieces, at Shoeburyness, &c.*—continued.

During the first experiments there was no failure of the vent-pieces of the Armstrong gun, *Sir W. Wiseman* 157——With regard to the large number of vent-pieces which have broken at Shoeburyness, these were no doubt chiefly of the old pattern, *ib.* 179, 180. 290, 291.

With regard to the vent-piece broken at the trial of some Armstrong guns at Portsmouth it was of the old and unimproved pattern, and the manufacture may not have been to blame, *Bingham* 519–523——Explanation as to the issue by witness, of some obsolete vent-pieces for guns at Portsmouth, *Gordon* 999–1002.

Defect of the gun for the navy on account of the accidents arising from the vent-piece, *Cochrane* 2236. 2262–2268. 2278, 2279——Several instances of accidents in the navy in connection with the vent-pieces, *Admiral Dacres* 3182–3190.

The chief defect of the gun arises from the vent-pieces which, in the heat of action, might not always be properly screwed up, *Hewlett* 3273. 3331. 3384——Statement as to the very few failures of vent-pieces on board the "Excellent," notwithstanding the great extent of the practice, *ib.* 3284–3291. 3378, 3379.

Weakness of the vent-piece adverted to as a great objection to the Armstrong gun, *Duke of Somerset* 5131. 5139——There were at first several failures of vent-pieces of guns tried in the navy, but it was fully expected that this defect would soon be remedied, *ib.* 5179. 5180.

Statements by Captain Jermingham and other officers explanatory of the results as regards the vent pieces of the Armstrong guns with which experiments were made on board the "Cambridge," &c.; return showing in detail the effect produced upon the vent-pieces, *App.* 310 *et seq.*

Reports from the Ordnance Select Committee in 1862 and 1863 upon the subject of the failure of vent-pieces for Armstrong guns of different calibres, *App.* 350–355.

Report in May 1862 on the fracture of the vent piece of a 100-pounder Armstrong gun on board the "Excellent"; this vent-piece had been kept exclusively for firing and had fired 160 rounds, *App.* 451.

Letters relative to the blowing out of the vent-pieces of an Armstrong 12-pounder on board the "Harrier" 's pinnace, off New Zealand, whereby six of her men were wounded and two other persons were injured, *App.* 470, 471.

List of vent-pieces cracked whilst carrying on experiments with Captain Coles's gun shield, on board the "Trusty," *App.* 471.

2. *Explanation by Sir W. Armstrong, as to the comparatively small number of failures in proportion to the Practice:*

Statement explanatory of the different failures of vent-pieces from time to time, showing that the total failures under all circumstances have been 117, whilst hardly less than 60,000 rounds have been fired, *Sir W. G. Armstrong* 3464. 3472–3477. 3867——Calculation that sixty-seven vent-pieces have failed at Shoeburyness, out of 37,184 rounds, *ib.* 3486.

3. *Difficulty more especially in the case of the Larger Guns:*

Disadvantage of the heavier guns, on account of the liability of the vent-pieces to break, *Sir W. Wiseman* 175–183. 186, 187. 289——Statement as to the 12-pounder vent-pieces having been satisfactory from the first, *Noble* 3130——Opinion as to the satisfactory character of the Armstrong vent-pieces up to the 40-pounders, *ib.* 3138, 3139.

Difficulty still to be overcome with regard to the 100-pounder vent-pieces; satisfactory result of a certain sliding arrangement adverted to hereon, *Sir W. G. Armstrong* 3263, 3264——Increased difficulty with the vent-piece according to the increased size of the gun, *ib.* 3464. 3483–3485. 3560——Liability of the 110-pounder vent-pieces to break; certain other defects with these vent-pieces are easily remediable, *ib.* 3560–3567.

Impression as to the unreliable character of the 110-pounder, on account of the liability of the vent-pieces to give way, *Jerningham* 3631, 3632. 3686–3688. 3701–3703. 3754–3760——Instances of vent-pieces having given way in the case of the 10-pounder and 12-pounder guns; on the whole, however, the vent-piece is quite satisfactory up to the 40-pounder, *ib.* 3641–3645. 3734——With regard to the question as to the propriety of so large an expenditure on Armstrong guns, witness considers that too large a number of 110-pounders were made, whilst the vent-pieces were yet unsatisfactory, *ib.* 3656–3679. 3686–3689. 3794.

Doubt as to the vent-pieces for the guns up to 40-pounders being yet successful, *Scott* 4422–4424.

List

VENT-PIECES (ARMSTRONG GUNS)—continued.

3. *Difficulty more especially in the case of the larger Guns*—continued.

List of Armstrong guns rendered unserviceable by proving vent-pieces; failures in the case of the 40-pounder and 110-pounder, whilst none of the 9-pounders, 12-pounders, or 20-pounders have been rendered unserviceable in proving, *App.* 530.

4. *Prevention of Accident if proper care be taken:*

With proper care, the Armstrong vent-pieces are not at all likely to get out of order in action at sea, *Hewlett* 3224-3332. 3382–3384——There is no reason why the vent-pieces should be blown out at all, that is, if due care be taken, *Jerningham* 3701–3703.

5. *Improvements effected from time to time, and further improvement anticipated:*

Prospect of the defect of the vent-pieces being remedied, *Sir W. Wiseman* 192–194. 296, 297——Considerable improvements recently made in the vent-pieces in the case of the 40-pounder guns, that is, by the use of Swedish iron; equal improvement expected as regards the 12-pounders, *Tulloh* 2688–2699. 2816–2822——Improvement recently in the 100-pounder vent-pieces, *Noble* 3140.

Non-failure of the steel vent-pieces as used with the 12-pounders, although when adopted for the 40-pounder they frequently failed, *Sir W. G. Armstrong* 3245, 3261——Wrought-iron vent-pieces have now been used for some time with 12-pounders, and there has not been one single instance of failure, *ib.* 3245. 3258–3261——Necessity of renewing steel vent-pieces after about 200 rounds, *ib.* 3255——Durable character of wrought-iron vent-pieces, more especially since witness has used a kind of Swedish iron for the purpose, *ib.* 3255–3263.

Several improvements made in the vent-pieces from time to time, *Sir W. G. Armstrong* 3256, 3257. 3261——Absence of failure with 40-pounder vent-pieces since the use of Swedish iron, *ib.* 3261–3263——Failure of several 40-pounder vent-pieces made of the ordinary forged iron, *ib.* 3262.

Good grounds for witness's confidence in the wrought-iron vent-pieces now used with the 9-pounders and 12-pounders; entire absence of failures since their use, *Sir W. G. Armstrong* 3444-3452——Uncertainty of steel further adverted to; mistake in having used it, *ib.* 3464–3466. 3479. 3604——Continual experiments made by witness with a view to perfecting the vent-pieces for the larger guns; good prospect of success, *ib.* 3899-3901.

6. *Statement of the changes in the Pattern, and of the authority for such changes:*

History of the changes in pattern and material of the vent-piece for the Armstrong guns, with the dates of the authority for the changes, *App.* 520.

Vickers, Mr. Very severe test withstood by the 40-pounder gun of Mr. Naylor Vickers, made from a solid mass of cast steel; cost of this gun, *Scott* 4439-4449.

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Wads (Armstrong Guns). Probable inconvenience in close action from the way in which the lubricating wad is screwed on, *Ewart* 4552.

Statements by Captain Jerningham and other officers explanatory of the results as regards the wads and the lubrication of the Armstrong guns with which experiments were made on board the "Cambridge," &c., *App.* 310 *et seq.*

Particulars of trials on board the "Excellent," in September 1860, with wads for the 40-pounder Armstrong gun, some of which were composed of two parts of lubricant and one of sawdust, and some of three parts of lubricant and one of sawdust, *App.* 427, 428——Satisfactory result of an experiment, in September 1860, with the Armstrong lubricating wads for the 40-pounder gun, *ib.*

Further experiments in February 1861, in order to test the lubricating qualities of certain wads composed of three parts of lubricant and one of sawdust, *App.* 436.

Details of experiments on board the "Excellent" in June 1861, with fifty felt lubricating wads for the Armstrong 100-pounder gun, which were apparently composed of felt and tallow, with a backing of half-inch elm, *App.* 437–439——Conclusion that the felt wad, though not lubricating the chamber at all satisfactorily, is very far superior in lubricating qualities to the sawdust wads, which for the 100-pounder gun, seems to be utterly useless, *ib.* 439.

Wainwright, Captain James, F. B., R.N. (Analysis of his Evidence.)—Commands the "Black Prince," has had some experience of the Armstrong gun, both on board the "Black Prince" and the "Shannon," 3767–3771. 3778——Should be very sorry to see the gun introduced generally into the Navy, 3771 *et seq.*——Approves however of the gun being retained on the main deck, on account of its great range and the destructiveness

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Wainwright, Captain James F. B., R.N. (Analysis of his Evidence)—*continued.*

tiveness of the shell, 3771. 3783. 3789——Considers that the gun is less accurate at sea than the smooth-bore gun; grounds for this conclusion, 3771–3777. 3790–3793. 3798.

Great inconvenience on board the "Black Prince" on account of the thickness of the smoke from the Armstrong gun, 3779——Defect of the gun in not being capable of ricochet firing, 3780. 3792——Bar to accuracy of aim on account of the slow-burning powder used with the gun, 3781, 3782——Much too complicated character of the gun, as compared with the smooth-bore gun, for use in close action; very prejudicial effect of any accidents under such circumstances, 3783. 3794–3797.

Objectionable character of the Armstrong fuzes; approval rather of the Boxer fuze, 3784–3786——Existence of certain flaws in the Armstrong guns under witness's charge, 3787, 3788——Special class of trained men required for the rifled breech-loader, 3799 3801——Witness prefers the old smooth-bore to the rifled gun, in general action, as well as against forts and iron plates, 3802–3810——The great expenditure on the Armstrong guns was hardly justifiable, their efficiency not having been properly proved by experience, 3811, 3812.

War Office. See *Accounts* (*Woolwich Departments*). *Armstrong Guns. Elswick Company. Expenditure. Experiments. Gun Factory. Navy, The*, 1. *Ordnance. Select Committee. Peel, General. Whitworth Guns and Projectiles.*

"Warrior," H. M. S. One fourth of the armament of the "Warrior" consists of Armstrong guns, which witness considers a very good proportion, *Cochrane* 2232–2235. 2249. 2275, 2276——There has been no accident with any Armstrong gun on board, *ib.* 2233.

The 68-pounders or the 110-pounders in the "Warrior" would not be effective against the French ship "La Gloire," *Blakely* 4821, 4822. 4829–4832.

Wear and Tear of Guns. Defect of the Armstrong breech-loader in the fact that it quickly becomes unserviceable from dust or rust, *Gardner* 33. 52, 53. 102, 103——Excellent manner in which the Armstrong guns sent to Canada bore the journey, *Bingham* 540——It is very doubtful whether the gun would answer with the rough usage it would get in war, *Sir R. Dacres* 2186——Very satisfactory manner in which the guns bear rough work or exposure to weather, *Sir W. G. Armstrong* 3228——Opinion as to the unsuitable character of the gun for the rough wear and tear of the service, *Scott* 4377.

Report from the Ordnance Select Committee, in December 1860, on the effect of exposure to the weather on Armstrong field pieces; very satisfactory conclusion arrived at, *App.* 484, 485.

Weight of Guns. With regard to the evidence given before the Ordnance Select Committee, witness objects to Colonel Lefroy's statement as to the inferiority of his seven-inch gun to the seven-inch gun of the service, on account of the former being three tons seven cwt. heavier; statement hereon as to the superiority also of witness's four ton five and a half-inch gun to the Armstrong seven-inch gun of the same weight, *Whitworth* 1998, 1999. 2006 *et seq.*——*See* also *Field Guns*, 2.

Welded Metal (*Wrought Iron*). Witness never made a gun of welded iron, and never would think of doing so, *Whitworth* 1316——Belief that welded metal is the worst material that can be used for a gun, *ib.* 1317. 1458——Use of welded coiled iron both for the inner tubes as well as the outer hoops of the Armstrong gun, *ib.* 1317, 1318.

Dissent from the opinion that welded wrought iron is not a fit metal for guns *Anderson* 1850. 1918——Frequent occurrence of defects in the welding; objection, however, to screwing or casting being applied to the coils or rings, *ib.* 1978–1983——Screwing would be stronger, but welding is less expensive, *ib.* 1978–1980.

System of witness to screw the hoops together, instead of to weld them; advantage thereof, *Whitworth* 2079. 2083–2091——Further disapproval of the present system at Woolwich as involving the use of wrought iron, *ib.* 2616, 2617——Witness reiterates his objection to wrought iron or welded metal as the material for guns, *ib.* 2973, 2974——Less liability to flaws in guns made of homogeneons metal than where welding is employed, *ib.* 2996–2999.

Great strength and durability derived from the welds lying transversly to the bore, *Sir W. G. Armstrong* 3163——Until the proper kind of steel can be provided, witness is satisfied that coiled barrels of wrought iron are the best alternative for steel, *ib.*——Dissent from Mr. Whitworth's view, that the external parts of the gun should be formed of steel cylinders, instead of wrought iron coils; important advantages of the latter, *ib.*——Admission that welds are very objectionable in the barrel in all cases, *ib.*

Undue importance attached by artillery officers to apparent defects in the welding of the guns, which look like partial openings in the coils; remarks by the Ordnance Select Committee

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Welded Metal (*Wrought Iron*)—continued.

Committee upon this question, *Sir W. G. Armstrong* 3846-3855——Further reference to the less objectionable character of the welds in their being transverse instead of longitudinal, to the bore, *ib.* 3857.

Reference to the object of the coil system as that of getting welds of wrought iron round the gun in that form the least mischievous, *Blakely* 4626——Advantage if the weld could be got rid of altogether, *ib.*

See also *Coil System.* *Duration or Endurance.* *Failures and Defects.* *Steel, or Homogeneous Metal.*

Whiffin, Henry W. S. (Analysis of his Evidence.)—Has prepared certain statements and calculations showing the sums paid to the Elswick Gun Company for guns and projectiles, as compared with the cost, if supplied by the Royal Gun Factory, 3073-3077——From one of these statements it appears that with respect to the sum of 593,275 *l.*, part of the amount paid to the Elswick Company, there would have been a saving of about 242,173 *l.* if the articles had been manufactured at the Gun Factory, 3077.

[Second Examination.]—Has recently prepared a paper, now before the Committee, in reply to a statement by Mr. Rendel, questioning the accuracy of a comparative account of the cost at Woolwich and at Elswick, 5573——The return or balance sheet submitted by witness to the Committee in 1862 represents accurately the cost to Government of the different articles made in the Gun Factory, 5575 *et seq.*——Witness showed in two ways the results from distributing the general charges, that is, as distributed on labour alone, and on labour and material; difference of about 10,000 *l.* as regards the guns made in 1861-62; 5576, 5577. 5587, 5588.

General approval of the manufacturing accounts by Mr. Anderson of the Treasury, 5578——Way in which interest and depreciation were dealt with in the Gun Factory balance sheet, as regards the capital spent upon machinery for the Armstrong guns, 5583, 5584. 5598. 5603, 5604. 5611. 5616-5621——Accuracy of the general result, showing for 1861-62 a total of 242,000 *l.* in favour of Woolwich as compared with Elswick, if all the guns had been made at the former place, 5585-5597——Explanation as to the omission from the accounts of cost at the Gun Factory of several charges which apply to Elswick and other private establishments, 5598-5610. 5631.

Reference to certain discrepancies between the return furnished in July 1862 and the return furnished this year, as for the sighting, &c., of guns; explanation thereupon, 5612-5615——Difficulty of making a Government account on commercial principles, although a comparison may be made, without much difficulty, between the prices of manufacture of a private firm and of Government, 5621-5627——Expediency of a principle being laid down as to the mode of distributing the general charges, 5628-5630.

Circumstances of the comparative statement of the Woolwich and Elswick prices not taking into account the much larger orders given to the Gun Factory, nor the date of manufacture, 5633-5641. 5644——Witness cannot find that there was any abatement from the sum of 700 *l.* paid for 100-pounders at Elswick, 5642, 5643——There were, doubtless, many circumstances affecting the comparison which it was not the function of witness to decide upon, 5644-5652——Probable enhancement, more especially of the Elswick prices for ammunition, by reason of the earlier manufacture and smaller orders than at Woolwich, 5648-5652.

Different rates arrived at as to the Government cost of the 100-pounder, so that a more satisfactory system of calculation is desirable, 5653-5656——Statement showing that the actual cost or value of the stores or stock in hand is not allowed for in the balance-sheet of the prices at Woolwich, 5657-5663——Way in which witness has treated the item of expenditure for new buildings and machinery, 5664-5667——Probability of there being a few more items proper to be comprised in the general expenses in distributing these upon the labour, 5668-5673.

Consideration of the question as to the expenses to be levied respectively on the miscellaneous productions in the Gun Factory, and on the guns; expediency of some definite principle being arrived at in this respect, 5674-5694——Approval of the incidental charges being levied on the direct labour, 5682, 5683——Further opinion that taking the three main elements of labour, material, and general charges, the comparative account of the prices at Woolwich and Elswick is substantially correct, 5686. 5704-5707.

Until the Gun Factory accounts were made up in their present form, the War Office were not in a position to know the difference between the prices at Woolwich and at Elswick, 5695-5698——Total cost of the several natures of guns supplied; aggregate of 793,239 *l.*, 5700, 5701——Still lower cost per gun at Woolwich if all the 100-pounders had been made there, 5702, 5703.

Whiffin, Mr. Letter from Mr. Whiffin, dated 6th July 1863, to the Chairman of the Committee, in reply to a letter from Mr. Rendel, dated 16th June 1863, relative to the cost of manufacture at Woolwich and at Elswick, *App.* 555-558.

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WHITWORTH GUNS AND PROJECTILES:

1. *Evidence explanatory of the Experiments with Mr. Whitworth's Guns, and of the General Merits of his System.*
2. *Projectiles or Shells.*
3. *Returns and Reports containing details of the several Trials, and of the Results obtained.*
4. *List of Committees appointed to consider Mr. Whitworth's Inventions:*
5. *Correspondence and Accounts relative to Expenditure on Experiments with Small Arms and Rifled Ordnance.*
6. *Correspondence relative to Origination of Polygonal Rifling.*
7. *Letter from Mr. Whitworth to Special Committee on Rifled Ordnance.*

1. *Evidence explanatory of the Experiments with Mr. Whitworth's Guns, and of the General Merits of his System:*

Large number of experiments carried out by the Ordnance Select Committee between the Armstrong and Whitworth guns, *Sir W. Wiseman* 125, 126——Explanations as to the Committee not having visited Mr. Whitworth's manufactory, *ib.* 127. 145–147——Inadequate means afforded to the Committee for properly testing the merits of the Whitworth guns, on account chiefly of the great difficulty in obtaining ammunition, *ib.* 127–130. 132. 136–144. 266——Alteration in the Whitworth shell since the time of the experiments, *ib.* 141, 142——Inaccuracy of statements that Mr. Whitworth was unfairly dealt with by the Committee, and that necessary facilities were not afforded to him as to Mr. Armstrong, *ib.* 145–150. 154–156.

Witness has not seen much of Mr. Whitworth's guns, but thinks they are quite equal to the Armstrong guns, *Sir W. Wiseman* 280, 281——Disapproval of the smaller Armstrong guns being altogether superseded by the Whitworth guns; great expense of the change, *ib.* 295. 301–304.

With regard to some experiments at Shorncliffe between Whitworth and Armstrong guns; the firing from the former was very good but not a bit better than from the latter, *Bingham* 341–344——Circumstance of Mr. Whitworth not having produced a satisfactory shell or fuse, *ib.* 533. 539——Relative merits, on the score of endurance, &c., of the Whitworth gun and the Armstrong gun; witness cannot give any definite conclusion hereon, *Anderson* 736–739. 748–758——Construction, in the Gun Factory, of a Whitworth 12-pounder, made on the coil principle; alteration and improvement in the plans for this gun as first supplied by Mr. Whitworth, *ib.* 855–864.

Less trial of the Whitworth guns than of the Armstrong guns owing very much to difficulties raised by Mr. Whitworth, *H.R.H. The Duke of Cambridge* 1239–1241.

The Whitworth gun was tried eight or nine times, and the Armstrong gun about fifty times, *Noble* 3081–3085——Mr. Whitworth was present at trials when diagrams of his gun were made, *ib.* 3086–3090. 3133—— Due notice of the trials of his gun was always given to Mr. Whitworth, and he was afforded every facility to be present; in point of fact, he was present at nearly all the trials, *ib.* 3087–3104. 3126–3131. 3133——The records of the Committee would not show upon which occasion Mr. Whitworth was present, or that previous notice was given to him, *ib.* 3091–3095.

The reason Mr. Whitworth's gun did not receive the same extended trial as the Armstrong gun was that he only provided shot and common shell without fuses, whereas Sir W. Armstrong had a perfect fuse and shrapnel shell, *Noble* 3105–3115——At this period Mr. Whitworth had not a gun of his own construction, but had merely rifled Government blocks of brass and cast iron, *ib.* 3105——Fuses might in time have been prepared by Government for the Whitworth shell with a view to a more perfect trial, but it was not the province of a Committee on Rifled Ordnance to undertake this matter, *ib.* 3106–3115. 3122–3125——Inferiority of the Whitworth gun on all points on which compared with the Armstrong gun, *ib.* 3116–3121——Explanation upon the question of one shot with the Whitworth gun which fell very short of the range having been included in the calculations; propriety thereof, *ib.* 3134–3137.

Up to the period when the Committee on Rifled Cannon made their report, Mr. Whitworth had produced no new guns, but had merely rifled the service brass and cast-iron guns, *Sir W. G. Armstrong* 3228.

Excellent penetrating power of the Whitworth gun, *Hewlett* 3308——Conclusion as to the old Whitworth muzzle-loader not being a safe gun, on account of the tendency of the shot to get jammed in the bore, *ib.* 3309–3317. 3336–3338. 3344–3346. 3395–3412——Limited experience of witness with the Whitworth gun, *ib.* 3310, 3311. 3344–3351——Trial and failure of the Whitworth guns in France; report on the subject adverted to hereon, *Blakely* 4908. 4911, 4912.

Explanation as to witness having been anxious to see the Whitworth gun more fully tried; obstacles at first to their being made at Woolwich, *Duke of Somerset* 5183–5190——Limited character of the experiments with the Whitworth gun; delay at present in obtaining and testing one of these guns against an Armstrong gun, *ib.* 5191–5194——

Unwillingness

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WHITWORTH GUNS AND PROJECTILES—continued.

1. *Evidence explanatory of the Experiments, &c.*—continued.

Unwillingness of witness in 1860 to order Whitworth guns, as not having been proved and tested; failure of one of these guns on board the "Excellent," *Duke of Somerset*, 5195. 5203.

Trial made in 1860 of two Whitworth guns, an 80-pounder, and a 12-pounder, both breech-loaders, the result not having been at all satisfactory, *Baring* 5230–5233——Construction by Mr. Whitworth of four muzzle-loaders in accordance with a request from the War Office in August 1860; successful firing in the case of two of these guns, whilst one with a steel barrel failed in proof, *ib.* 5241–5243.

Communications between Mr. Whitworth and Captain Noble in November 1858 relative to experiments with the Whitworth 32-pounder, *App.* 401.

2. *Projectiles or Shells:*

Disadvantages of the principle of mechanical fit of projectiles, as compared with projectiles having a soft outer coating or thin covering of lead, *Sir W. G. Armstrong* 3165——Opinion strongly adverse to the use of steel spherical shot, as compared with elongated projectiles, *ib.* 3167——Successful invention by Mr. Whitworth in the matter of steel shot, *ib.*——Conclusion as to the tendency of the shot to get jammed in the bore of the old Whitworth muzzle-loader; danger thereby to the endurance of the gun, *Hewlett* 3309–3317. 3336–3338. 3344–3346. 3395–3416.

Examination as to the grounds for witness's objection to the mechanically-fitting projectile as involved in the polygonal system of rifling, *Sir W. G. Armstrong* 3912–3941. 3949–3967——The actual coincidence of the projectile with the form of the bore does not however really exist, *ib.* 3916——Way in which the system of polygonal rifling and mechanically-fitting projectiles involves a much greater amount of friction than the system of a lead-coated projectile, and endangers the stability and endurance of the gun, *ib.* 3925. 3935–3941. 3949–3967——Conclusion as to mechanically-fitting projectiles vibrating on issuing from the bore, *ib.* 3926, 3927.

Character of the experiments upon which witness bases his condemnation of the polygonal system of mechanically-fitting projectiles, *Sir W. G. Armstrong* 3928–3934. 3949 3958–3967——Denial that it is practicable to make the projectile so accurately correct, or so coincident with the bore, that it shall bear evenly over all the faces, *ib.* 3949——Reference to the experiments with the brass guns as fully bearing out witness's theory as to the injurious effects produced by mechanically-fitting projectiles, *ib.* 3961–3967——Statement to the effect that the lead-coated shot in the shunt gun does vibrate, but that the mechanically fitting projectile in the Whitworth gun does not vibrate, *Scott* 4475–4481——Considerable merit of the Whitworth projectile, *Duke of Somerset* 5204. 5206.

Report of the Ordnance Select Committee in 1862 relative to the initial velocities and penetrating power of the Whitworth shells, *App.* 371–374——Statement of the Ordnance Select Committee in November 1862, as to the merit due to Mr. Whitworth in respect of the steel shell, *ib.* 374, 375.

Diagrams explanatory of the construction of Mr. Whitworth's projectiles, *App.* 528.

Inadequate experiments for showing whether mechanical-fitting projectiles are liable to the objections made against them, that they must tend to destroy the gun, *Rep.* viii.

3. *Returns and Reports containing details of the several Trials, and of the Results obtained:*

Reports from the Ordnance Select Committee in 1862 on Mr. Whitworth's 12-pounder and 70-pounder guns, with reference more especially to the initial velocities of the projectiles, *App.* 371–375.

Return from H. M. S. "Excellent" of trials of rifled ordnance since 1 January 1858, showing in detail the working of, and the results obtained by Armstrong and Whitworth guns and projectiles of different natures, *App.* 408 *et seq.*——Details of trials with Mr. Whitworth's 24-pounder brass rifled howitzer, *ib.* 408–415——Return in October 1858, containing details of trials with the Whitworth 68-pounder in order to ascertain its effects against iron plates, *ib.* 416, 417——Result of experiments in January 1861, on board the "Stork" at Spithead, from a Whitworth 80-pounder breech-loading gun, in order to test its suitableness both as a breech and muzzle-loading naval gun, *ib.* 434, 435.

Copy of report, dated 17 March 1863, on the present condition of the Whitworth battery at Shorncliffe, comprising 12-pounder rifled brass guns, *App.* 458.

Report on experiments at Southport in 1860, with 80-pounder and 12-pounder Whitworth guns, showing in detail the results arrived at, *App.* 475–479.

Proceedings and report of the Special Committee ordered in 1858, to inquire into the expenses incurred by Mr. Whitworth in carrying out experiments on behalf of the Government; suggestions by the Committee that certain further experiments be made at an estimate cost of between 5,000 *l.* and 6,000 *l.*, *App.* 524, 525.

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WHITWORTH GUNS AND PROJECTILES—continued.

3. *Returns and Reports containing details, &c.*—continued.

Report of Messrs. Penn, Field, and Anderson, dated 11 April 1861, on the injury sustained by Mr. Whitworth's 5½ inch-bore gun, and the causes which led to its damaged condition, *App.* 528.

Report by Captain Hewlett, dated 4 February 1861, on the trial of Whitworth cannon on board the "Excellent," and showing several objections to the introduction of this gun into the navy, *App.* 554.

4. *List of Committees appointed to consider Mr. Whitworth's Inventions:*

Return of the various Committees appointed to inquire into and report on the system proposed by Mr. Whitworth to be adopted in fire-arms, in the period from March 1854 to the end of 1862, *App.* 295–297.

5. *Correspondence and Accounts relative to Expenditure on Experiments with Small Arms and Rifled Ordnance:*

Abstract of correspondence between Mr. Whitworth and the War Office from 1854 to 1860, on the subject connected with small arms and large ordnance; together with a detail of portion of the expenses on account of those experiments, referred to in return (at p. 283 of the Report of the Committee on Ordnance), dated July 1862, amounting to 11,292 *l.* 7 *s.* 1 *d.*, *App.* 382-393.

6. *Correspondence relative to Origination of Polygonal Rifling:*

Letter from Mr. Isambard Brunel to the Chairman of the Committee, dated 27 April 1863, enclosing certain correspondence of the late Mr. Brunel and Mr. Westley Richards as establishing the fact that the former had in 1852 conceived the idea of a polygonal rifle, and that Mr. Whitworth had subsequently been in communication with Mr. Richards on the subject, that is, in 1854, *App.* 402, 403.

Letter from Mr. Westley Richards to Mr. Isambard Brunel, dated 30 June 1863, stating that in 1854, Mr. Richards told Mr. Whitworth that he had made a polygonal rifle for Mr. Brunel, and fully discussed the idea of this rifle with Mr. Whitworth, but that the latter did not say that he himself had conceived the idea, or made a model of a polygonal rifle, *App.* 548.

7. *Letter from Mr. Whitworth to Special Committee on Rifled Ordnance:*

Letter from Mr. Whitworth to the President of the Special Committee on Rifled Cannon, dated 14 October 1858, explanatory generally of his views on the subject of rifled ordnance, *App.* 400.

See also the headings generally throughout the Index, and the explanations in the Analysis of Evidence of Mr. Whitworth.

Whitworth, Joseph. (Analysis of his Evidence.)—Explanatory statement upon the subject of a report by the Ordnance Select Committee in November last, wherein the personal honour of witness, and the originality of his system of rifling is called in question, 1099 *et seq.*——Comment upon the unfair mode in which the Committee conducted their investigation; witness was in fact condemned unheard, and was not aware until very recently that any report had been made at all, 1099. 1102–1121.

Written statement and examination in detail relative to the drawings supplied by witness to Mr. Anderson for the construction of his 7-inch gun at Woolwich, and the alterations made therein by Mr. Anderson, in order to adapt the construction to the mode of manufacture at the Gun Factory; denial that the altered drawings involved any essential difference, 1099–1102. 1125 *et seq.*——Consultation between witness's partner and Mr. Anderson with reference to the modifications first proposed by the latter in witness's original drawing, 1102.

Material differences between the 7-inch gun designed by witness and the Armstrong 7-inch gun; much greater weight of the former, 1102. 1129——Reference to several letters from Mr. Anderson as mentioning the slight character of the alterations proposed by him and ultimately assented to by witness, 1102——The Ordnance Select Committee were in fact altogether unjustified for reporting that witness made an incorrect assertion in his letter to the "Times" on the 8th November, when he said that the 7-inch gun was made according to drawings supplied by himself, 1102 *et seq.*

Comment upon the statement of the Ordnance Select Committee that "the more modern and perfect developement of the hexagonal system of rifling originated with the late Mr. Brunel," 1102.

Witness adheres to the statements in his letter to the "Times," in November last, 1122–1124 —— The foregoing letter read; consideration therein of the merits of witness's guns as compared with the Armstrong gun, 1130——Statement in this letter that the coil principle of the Armstrong gun had been adopted in this country some years ago, and that witness himself had used the coils in 1855; 1130——Desire expressed by witness in this letter to aid the public service in every way in his power, *ib.*

Further evidence to the effect that the mode of manufacture at Woolwich being differen

Whitworth, Joseph. (Analysis of his Evidence)—*continued.*

different from witness's mode, he left it to Mr. Anderson to carry out the details of his gun, but that the deviations from the original drawings are not material, 1131 *et seq.*——Concurrence of Mr. Anderson in the written statement of witness relative to the 7-inch gun, 1132——Witness would have preferred an implicit adherence to the original drawings, 1144. 1156.

Inaccuracy of a statement by the Ordnance Select Committee that the metal in witness's 7-inch gun is not differently distributed from that of the service guns, 1177-1182——Reference to the circumstance of coils having been used in witness's gun made at Woolwich, 1195-1199——Intention in witness's original drawing to have a solid forged breech piece, 1200-1203——Statement as to the coil principle having been used in fowling pieces for some years, and as to witness having described the process in his patent of 1854; 1204-1213.

[Second Examination.]—Explanation that witness's patent of 1854 did not contemplate the same system of coils or hoops adopted by Sir W. Armstrong; distinct character of the process of making the hoop on the principle of coils, 1265-1285——Examination upon the question of witness having made a gun in 1855 with hoops of welded coiled iron; explanation that this gun was not finished, 1286-1307. 1327, 1328. 1347-1358——Instances subsequently to 1855 of witness having made guns of coiled iron welded, 1308--1311.

Distinction between the Armstrong gun and witness's gun, that the tubes of the former are composed of welded iron on the coil principle, whilst witness has always used an inner tube made from a solid bar, not coiled, 1311-1319——Belief that welded metal is the worst material that can be used for a gun, 1317. 1458——Further statement that the coil principle is not new, and has been used for years for fowling pieces, 1320-1326——Explanation as to the date at which witness first turned his attention to, or undertook the construction or rifling of ordnance on an improved principle, 1329-1353.

Further examination on the question of the polygonal system of rifling having been due to the late Mr. Brunel before; witness states positively that when he first experimented with the polygonal system he had no knowledge of the polygonal rifle constructed for Mr. Brunel, 1385-1409.

Statement to the effect that witness has not been paid for the experiments with rifled ordnance which he undertook at the request of Lord Hardinge; he has received 15,885 *l.* for experiments with rifled gun barrels, and 4,735 *l.* for what he has supplied as an ordnance manufacturer, but is 10,278 *l.* out of pocket by his experiments with ordnance, 1411-1445.

Valuable assistance derived by witness from Mr. Anderson in the manufacture of his seven-inch gun at Woolwich, 1447-1450——Opinion that Sir W. Armstrong's principle is utterly wrong, 1451——Explanation as to witness having been obliged to have recourse to the Royal Gun Factory for the manufacture of his seven-inch gun on account of the machinery there available, 1452-1460——Great value attached to the system of manufacture of Krupp, of Essen, 1454——Manufacture of several of witness's guns with homogeneous metal; this manufacture is now going on, 1461-1466——Witness would never think of building up a gun so small as a six-pounder or twelve-pounder, 1464.

[Third Examination.]—With regard to the evidence given before the Ordnance Select Committee, witness objects to Colonel Lefroy's statement as to the inferiority of his seven-inch gun to the seven-inch gun of the service, on account of the former being three tons seven cwt. heavier; statement hereon as to the superiority, also, of witness's four ton five and a half-inch gun to the Armstrong seven-inch gun of the same weight, 1998, 1999. 2006 *et seq.*——Exception taken to the statement before the Ordnance Select Committee that the quick rifling turn adopted by witness strains the gun excessively, 2000-2005.

Statement as to the charge of powder and weight of projectile used with witness's four ton gun and the service four ton gun; denial that the latter has any advantage hereon, 2007 *et seq.*——Belief that some of witness's guns have been in actual service, and have done well, 2031-2033——Explanation as to the mode of construction and the performances respectively of two guns made for witness at Woolwich, and of two guns made at Manchester; it was one of the former guns that was found so successful against iron plates, 2053-2071——Use of homogeneous metal in the two guns made at Woolwich, 2067-2071.

Explanation as to witness's firm having, in May 1861, applied for some coiled tubes from the Gun Factory, not having then adequate furnaces for annealing homogeneous metal, 2072-2074——Witness now recommends that the tubes and hoops be made of homogeneous metal, and that the hoops be put on by hydraulic pressure, 2075-2079——System of witness to screw the hoops together, instead of to weld them; advantage thereof, 2079. 2083-2091.

(*Mr. Baker.*)—Six hoops were supplied to Mr. Whitworth from the Gun Factory for his five and a half-inch gun, 2080-2082.

Report, 1863—*continued.*

Whitworth, Joseph (Analysis of his Evidence)—*continued.*

[Fourth Examination.]—Explanation on the subject of the initial velocity of witness's 12-pounder gun as compared with the Armstrong 12-pounder, 2350——Reference to a statement by the Ordnance Select Committee that spherical shot would be most effective against iron-plated ships at very short ranges, 2350–2353——Witness never saw the official report upon the experiments made with his gun at Southport in 1860, but has reason to believe it was favourable, 2354, 2355. 2488——Inaccuracy of a statement that witness's guns have been unfavourably reported upon by a committee of artillery officers in France, and have been rejected there, 2356–2364.

Exception taken to the evidence of Sir W. Wiseman as to great difficulty having been experienced by the Ordnance Select Committee in obtaining ammunition from witness when first testing his gun, 2365 *et seq.*——Supply by witness of shot and hollow shell, which were sufficient for testing the range and accuracy, without his having supplied any fuze for the shell; examination on this latter point, 2366–2415.

No opportunity was given to witness to be present at the comparative trial of his gun and the Armstrong gun, nor was he aware of such trial before the adoption of the latter, 2416–2418. 2426——Circumstance of the gun submitted by witness for trial having been a Government gun, rifled on his principle, whilst the gun of Sir W. Armstrong was not only rifled, but was originated by him, 2419–2432——Date of the first complete gun supplied by witness; it was a 70-pounder breech-loading gun, with a homogeneous tube, and wrought-iron hoops, 2423–2428——Inaccurate results obtained as to the shooting of witness's twelve-pounder at the trial on 2d April 1861, witness not having been present to correct or protest against the error, 2433–2444.

Further reference to the original adoption by witness of the polygonal system of rifling; he disclaims having been led to the system in consequence of the previous adoption of it by Mr. Brunel, of which he was not at the time aware, 2445, 2446. 2545–2551. 2602–2610——Particular advantages of the polygonal form of rifling, 2446, 2447. 2454–2463——Simple and economical character of the projectiles which may be used with witness's guns, 2447. 2497–2511——Slight modification, since 1858, of the hexagonal system then submitted by witness to the Ordnance Select Committee, 2447–2453.

Greater initial velocity with a rifled spherical shot than with a shot not rifled, 2457–2462——Advantage of witness's system of rifling in its being equally applicable to both breech-loading and muzzle-loading, 2463——Witness is not a partizan of the breech-loading gun, 2464——Much greater simplicity of the muzzle-loader, whilst it can be loaded and fired quite as quickly as the other, 2464, 2465——Very small wear of witness's guns, 2466.

Number and size of brass and cast-iron guns rifled by witness for Government previously to 1859; 2467, 2468. 2504–2509——Bursting of the cast-iron guns rifled by witness in 1858, and consequent intimation from Government that no more guns wer to be rifled on his principle, 2469–2477——Necessity of an extra strengthening of guns rifled on the polygonal principle, 2478–2480——Success attained by some cast-iron rifled guns when low charges and short projectiles have been used, 2481–2484——Satisfactory experiments with some brass guns rifled by witness for the naval service before 1859; 2485, 2486.

Further reference to the use by witness of homogeneous metal for the inner tube, as far superior to welded metal or wrought iron, 2487. 2616, 2617——Different guns of witness which have been used against plated targets at Shoeburyness, and important results obtained, 2489——Various sizes and prices of the guns now being made by witness's firm at Manchester, 2490–2497——Much less cost of the projectiles for witness's guns than for the Armstrong guns, 2497–2511——Both the guns and the ammunition of witness were in existence when the Armstrong guns and projectiles were adopted into the service, 2504–2511.

Admission by witness as to his having been in error in assuming that Sir W. Wiseman was a member of the Ordnance Select Committee in 1858 when a programme of the trials to be made with the two guns was previously submitted to Sir W. Armstrong, 2512–2527——Further statement with reference to the bursting of witness's guns in 1858, upon which Government discontinued the experiments; successful results however from the brass guns rifled by him at this period, 2528–2544.

Similarity of the shot used by witness in 1858 to that now used by him, except as regards the alteration of the outward form, the chief effect of which is to secure greater range, 2552–2560. 2577–2581——Statement as to witness having first proposed in 1859 to use homogeneous iron, and having in 1861 made application to Woolwich with a view to trying his principle of rifling with large guns made on the coil system, 2561–2570. 2593–2595——Excellent results obtained from the use of homogeneous metal for the smaller guns, 2565.

With regard to the reported failure of the battery supplied by witness to Shorncliffe, the trial to which these guns have been subjected is of a very exceptional character, 2571–2576——Bursting of different guns rifled by witness further adverted to; his five and a half-inch gun made of homogeneous metal did not however burst, although the inner tube

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Whitworth, Joseph. (Analysis of his Evidence)—*continued.*

tube was cracked, 2582–2592 —— Further reference to the circumstance of the coil principle not being new, 2596——Use of the ordinary service powder for witness's gun, 2597–2601——The recoil is less than that of the service gun, 2600.

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Circumstance of shrapnel shell for experiments with witness's gun having, upon his application, been made by Colonel Boxer, and having answered very well; this was long subsequent to the experiments in 1858; 3025–3029——Exception taken to the objection of the Ordnance Select Committee in 1858 that with witness's gun the shell was less accurate than the shot, 3030——With regard to the careful washing and drying said to be necessary with witness's gun, he was the first to introduce the system of lubrication, which has been found quite successful, 3031——Decided advantage of the flat-fronted over the round-fronted projectile, 3032.

Expediency of further official trials with a view to determine the most enduring kind of ordnance, 3033——Consideration of the grounds of witness's complaint that he had not an opportunity of being present at the trials between his gun and the Armstrong gun; he was present at several trials of his own gun, and cannot say that both guns were ever tried at the same time, 3034–3063——Sir W. Armstrong was not present when witness's gun was tried, 3057——Witness's gun was not sufficiently tried at all, 3046. 3058, 3059. 3063——Inaccuracy of certain diagrams of witness's system as supplied by Sir W. Wiseman, 3070–3072.

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"*Wrangler,*" *H. M. S.* Account of the trial of an Armstrong 32-pounder and 70-pounder on board the "Wrangler," in November 1859, *App.* 420–422.

Wrought Iron. See *Coil System. Duration or Endurance. Failures and Defects. Steel, or Homogeneous Metal. Welded Metal* (*Wrought Iron*).